ATTACHMENT K

TO: David K. Paylor

FROM: Alan E. Pollock

DATE: July 20, 2010

COPIES: Ellen Gilinsky

SUBJECT: **CONCERNS WITH JULY 1 DRAFT NUTRIENT ALLOCATIONS FOR THE JAMES RIVER BASIN BASED ON CHLOROPHYLL CRITERIA**

EXECUTIVE SUMMARY

- Proper assessment of model output must recognize the significant spatial and temporal variability of chlorophyll levels, in contrast to the more predictable dissolved oxygen patterns.

- EPA recognized this variability during the cooperative development process for the chlorophyll criteria in 2005, and included significant modeling evaluation of alternatives to address this issue. EPA approved the Virginia criteria based upon model assessment rules appropriate for chlorophyll attainment, in contrast to the rules that were used to develop the July 1 James River draft allocations.

- Recent information from the lower tidal James River 2010 Water Quality Assessment shows attainment, or at most 1% non-attainment, for those river segments. The expected reductions needed to meet the "dissolved oxygen-based" James River allocation [TN = 26.79 MPY; TP = 2.69 MPY] should achieve the criteria in this portion of the river without the additional reductions proposed by EPA.

- The additional reductions identified in the July 1 letter, which we do not believe are justified at this time, would increase costs to the citizens of the Commonwealth upwards of $500 million.

- Based on model results received from EPA in the past few days, absent the imposition of the chlorophyll issue in the James, the Virginia Tributary Strategy level of reductions would meet the draft nutrient allocations assigned to the Commonwealth.

CONCERNS WITH JULY 1 DRAFT NUTRIENT ALLOCATIONS FOR JAMES RIVER BASIN

I. <u>Methodology used to Develop Draft Allocations to Meet Chlorophyll Criteria is Not Appropriate</u>

- Chlorophyll model calibration is difficult due to its high natural variability. Caution must be taken in evaluating model results as the basis for assessing attainment and setting nutrient allocations for compliance with chlorophyll criteria.

- Concern that changes in chlorophyll (on the order of 1-2 ug/l seasonal average and 2-4% in terms of non-attainment rates) are smaller than those than can be precisely distinguished by the model, detected in monitoring data, or concluded to have ecological significance.

- The rules and procedures to assess model output need to be carefully examined to see what is appropriate for the chlorophyll parameter in contrast to what is appropriate for dissolved oxygen. Refer to **Attachment A**,which summarizes the differences between these two parameters regarding precision of analytical methods, confidence of impairment, environmental variability, etc. For the Bay TMDL, EPA is using a "1% non-attainment rule" when evaluating model scenario output for judging dissolved oxygen attainment. We have not yet seen EPA's documentation to justify using the "1% non-attainment rule" for interpreting model results for dissolved oxygen. However, we continue to be concerned that using the "1% non-attainment rule" for modeling attainment for chlorophyll, given the significant differences in these parameters, is not technically justified.

  As discussed in more detail below under section II, when the chlorophyll standards were adopted in 2005, EPA endorsed using model assessment rules different from the rules used to establish the July 1 draft allocations. Model predictions allowed up to a 4% non-attainment rule for assessing attainability with the proposed standards for several of the criteria.

- **Attachment B** presents the results of the 2008 and 2010 Water Quality Assessments for the chlorophyll criteria in the tidal James River. The following conclusions are drawn by using the results of the 2010 Assessment [data from 2006-08] and the assessment procedures developed by EPA (2010) and being adopted into the Virginia Water Quality Standards, i.e., the far right column, **2010 IR Geo Mean Status**.

  1. The three lower James River segments for both spring and summer either attain standards, or are within 1% non-attainment. The most recent model results as analyzed by EPA show non-attainment in at least one season in these three segments for several 3-year cycles under the allocations based on meeting the dissolved oxygen criteria [TN = 26.79 MPY; TP = 2.69 MPY].

     Based on recent emails from EPA staff, we understand that in developing the proper allocations to address the chlorophyll criteria in the DC Potomac and Anacostia Rivers, EPA used additional lines of evidence, not just model output and data from the 1990s. One email stated: "For the [P]otomac, the current *monitoring* data showed the [P]otomac is in attainment for Chl[orophyll] and the [A]nacostia is only 4% non-attainment. That information combined with the fact that the [P]otomac allocation still requires additional load reductions beyond current loads made us conclude that these segments will attain for chl[orophyll] at the allocated load." It appears to us that a consistent line of evidence approach should be used for the lower James River segments where most recent data shows that they are currently either in attainment or at 1% non-attainment.

2. The 2010 Assessment shows non-attainment in both the James upper and lower Tidal Fresh segments for both seasons, especially for the summer season. However, for the upper Tidal Fresh segment, the model is showing attainment in both seasons for all of the 3-year cycles. For the lower Tidal Fresh in the spring, the model shows slight 2% non-attainment. For the lower Tidal Fresh in the summer, the model shows persistent non-attainment in half of the 3-year cycle periods.

   Given this situation, we have little confidence in using the model to assess attainment in these tidal fresh segments. The main conclusion we draw is that the monitoring data are still pointing us towards the real chlorophyll problem in the James, which is the tidal fresh sections, particularly the lower tidal fresh in the summer. As discussed in section II, Virginia needs to review the summer tidal fresh criteria, particularly the application of the Harmful Algal Bloom criteria published by EPA. We believe if EPA used the same model assessment rules for the 2010 TMDL that were used in the standards adoption process in 2005, Virginia would have the opportunity to conduct the necessary review and update of the chlorophyll criteria without unjustified allocations in the 2010 TMDL.

- For chlorophyll, EPA is assessing model results by requiring attainment throughout the entire 10-year modeling assessment period, i.e., the criteria must be met in all eight 3-year cycles. However, EPA worked though a consensus process that identified one 3-year cycle that accounts for critical conditions in setting allocations for dissolved oxygen criteria. They are also doing the same for SAV/clarity criteria.

  We continue to be concerned that the critical condition approach used for the chlorophyll criteria is overly conservative by requiring compliance in every assessment cycle over the entire model simulation period, especially compared to the other two water quality criteria in the Bay. In addition, as noted in section II below, when Virginia adopted the chlorophyll standards in 2005, EPA endorsed using model assessment of attainability for both a ten year average, as well as looking at the rolling 3-year averages.

- We are concerned over the lack of examination of the same problems that cause counterintuitive model results in some segment-seasons might also be causing more systematic, less obvious problems in other segment-seasons. We believe there is a need to develop a set of objective criteria for evaluating model behavior that includes: (1) a systematic evaluation of the ability of the model to quantify changes in chlorophyll; and (2) an evaluation of the causes of problematic model chlorophyll predictions, and how those causes might affect the model accuracy/precision in all of the James River segments for both spring and summer seasons.

- It is doubtful that Virginia would have taken the step of being the first to adopt numeric chlorophyll criteria if EPA had applied the model attainability rules currently being used, i.e. 1% non-attainment rule and requiring attainment in all 3-year assessment cycles in the simulation period.

II. Need to Acknowledge the Basis for the Existing James River Chlorophyll Criteria and the Need to Review/Update those Criteria

- In March 2005, the State Water Control Board adopted water quality standards to protect the Chesapeake Bay and tidal rivers; these standards included five new designated uses, numeric criteria for dissolved oxygen, SAV and water clarity, and a narrative chlorophyll criterion. Action on numeric chlorophyll criteria for the tidal James River was delayed to give further consideration to public comments and to develop nutrient loading and cost alternative analyses. The Board considered the James River chlorophyll criteria at their June 2005 meeting, and adopted criteria at their November 2005 meeting.

- Earlier in the decade EPA chose not to develop Baywide numeric chlorophyll criteria following extensive review, scientific investigation and debate within the Chesapeake Bay Program. Therefore, the cooperative process between the Commonwealth and EPA to develop the chlorophyll criteria for the James River was "plowing new ground". The process resulted in new investigation, using several lines of evidence, such as reference sites, information on harmful or nuisance aquatic plant life, undesirable food conditions, natural characteristics of the James River, and attainability of criteria under various nutrient reductions in the basin.

- Much debate and controversy developed among the stakeholders during the rulemaking process. Legislation drafted by a member of the General Assembly, that would require justification of tangible benefits to the environment and the public, was held in abeyance as long as a solution agreeable to all parties was achieved. Considerable work was devoted to developing and analyzing alternatives with the EPA model to meet various proposed criteria within the five river segments and two seasons. A **James River Alternatives Analysis,** along with four addenda, was developed and became the focus of the on-going debate. EPA model analysis of alternatives, and the model results, became the center of debate throughout this process.

- EPA presented model output, and worked alongside DEQ and the stakeholders in evaluating that model output for the alternatives, in the following ways:

    - Model output was evaluated using 10 year averages of attainment over the assessment period of 1985 to 1994
    - Model output was evaluated without any rule calling for attainment throughout all eight 3-year cycle periods
    - Model output was evaluated without any rule calling for less than 1% non-attainment.

- Based upon that partnership work, DEQ staff, by memo dated June 22, 2005 to the State Water Control Board, in describing the results of the various alternatives evaluated up to that time, stated: *"However, most of the non-attainment under the VATS scenario was less than 4%, which staff believes is within the uncertainty band of the model…."*

- Seventeen alternatives were evaluated by the time the Board adopted the criteria. The final proposal presented to the Board at their November 21, 2005 meeting, which EPA supported, addressed the ten segment-season criteria as follows:
    - Four criteria included upward adjustments from original proposed criteria, using the rationale of "attainability but still within environmentally protective ranges"
    - Two criteria remained unchanged showing non-attainment of 3-4%
    - Four criteria remained unchanged showing attainment

- DEQ submitted the adopted chlorophyll criteria, and supporting documentation to EPA, on January 12, 2006, noting that "Each of these site-specific standards was developed with EPA Region 3 input and assistance."

- EPA approved these criteria by letter dated, January 12, 2006. Approving these standards the same day is a clear indication that EPA was fully involved and aware of the basis for the chlorophyll criteria and supported that process.

- Likewise, EPA provided written support for a related regulatory action during that same period when the State Water Control Board amended the Virginia Water Quality Management Planning regulation to incorporate nutrient allocations for 125 significant discharges, including those within the James River basin to achieve the adopted chlorophyll standards. EPA's letter stated: "The allocations are supportive of Virginia's proposed chlorophyll *a* water quality criteria for the tidal James River and its tidal tributaries."

- Subsequent to the previously described actions, EPA also approved the Chesapeake Bay Watershed General Permit, effective date of January 1, 2007, that included the allocations in the WQMP regulation.

- The Commonwealth clearly understands that the science is evolving regarding the use of chlorophyll criteria in the management of nutrient enrichment of our waters. We intend to initiate a review of the criteria during our next Triennial Review to evaluate any new science and recent monitoring data. We also know that EPA has published criteria to address harmful algae blooms in tidal fresh waters during the summer season. That information will be closely reviewed since the lower tidal fresh segment of the James continues to be an area of concern. We also believe that a full evaluation of the proper assessment tools is warranted, for both monitoring and modeling data.

III. <u>Impacts to Virginia Programs</u>

- Reducing an additional 3.3 MPY of Nitrogen and 0.35 MPY of Phosphorus in the James River basin as called for by the July 1 draft allocations is estimated to cost upwards of an additional $500 Million beyond the cost of implementing Tributary Strategy level of practices.

- Based on our experience during the criteria development process, we are concerned that EPA's July 1 letter will open up the Bay TMDL process in Virginia to legislative response. We are also concerned that the clean-up effort in the Commonwealth will be delayed due to appeals of the TMDL over the July 1 draft allocations.

Attachment A
Comparison of Chlorophyll vs. D.O.

Characteristic	Chlorophyll	Dissolved Oxygen	Implication for Assessment and TMDL
Criteria Parameter Type	Biological Stressor (i.e. Algal Biomass)	Chemical Stressor (i.e. Oxygen Concentration).	*Chlorophyll assessment/TMDL less accurate and precise.*
Impairment Confidence	Lower: Based on relatively difficult to quantify standard of "balanced and indigenous population"	Higher: Based on controlled laboratory studies of direct impact on living organisms. e.g. observed health or death of organisms.	*Chlorophyll assessment/TMDL Impairment level less accurately defined.*
Criteria Evolution	Newer EPA publications since 2005; science still developing	No Change Since 2005	*Chlorophyll criteria should be revised.*
Criteria Metric	Seasonal geometric mean	30 day, 7-day, 1-day, averages; instantaneous	*Chlorophyll assessment/TMDL less precise (Due to longer averaging period*
Parameter Analysis Method	Multi-step Laboratory analysis	Electronic field meter	*Chlorophyll assessment/TMDL data less accurate and precise.*
Data Quantity/Quality Trends	Model is using data collected in 1990's; collection and analysis methods have changed since that time	Methods are high quality; have not changed since beginning in 1985	*Chlorophyll TMDL data less accurate and precise.*
Analytical Method Variability	Higher (16%: median relative percent difference between intra-laboratory splits in James River during 1990's)	Lower (0.7%: ratio of precision [Standard Methods 21st edition] to mean measured summer D.O. during 1990's)	*Chlorophyll assessment less accurate and precise.*
Environmental Variability (1)	Higher (% 116.5 ± 14.0 [spring], %122.3 ± 9.3 [summer])	Lower (% 15.5 ± 0.9 [summer])	*Chlorophyll assessment less accurate and precise.*
Model Calibration	Lower Accuracy	Higher Accuracy	*Chlorophyll TMDL model predictions less accurate.*
Model Prediction Ability	Lower Accuracy	Higher Accuracy	*Chlorophyll TMDL model predictions less accurate.*

1) Average and range of coefficient of variation for four 3-year assessment periods from1990 to 1998.

Attachment B

CBP Segment	2008 IR Arith Mean % non-attain	2008 IR Arith Mean Status	2008 IR Geo Mean % non-attain	2008 IR Geo Mean Status	2010 IR Arith Mean % non-attain	2010 IR Arith Mean Status	2010 IR Geo Mean % non-attain	2010 IR Geo Mean Status
JMSTF1 (James TF Lower) Spring	39	Fails	11	Fails	9	Fails	9	Fails
JMSTF1 (James TF Lower) Summer	47	Fails	46	Fails	33	Fails	31	Fails
JMSTF2 (James TF Upper) Spring	27	Fails	25	Fails	14	Fails	7	Fails
JMSTF2 (James TF Upper) Summer	25	Fails	25	Fails	41	Fails	31	Fails
JMSOH (James Oligohaline) Spring	21	Fails	7	Fails	7	Fails	1	Fails
JMSOH (James Oligohaline)Summer	0	Meets	0	Meets	0	Meets	0	Meets
JMSMH (James Mesohaline) Spring	30	Fails	17	Fails	9	Fails	0	Meets
JMSMH (James Mesohaline) Summer	25	Fails	17	Fails	9	Fails	1	Fails
JMSPH (James Polyhaline) Spring	21	Fails	7	Fails	0	Meets	0	Meets
JMSPH (James Polyhaline) Summer	30	Fails	9	Fails	8	Fails	0	Meets

Note: Above 303(d) assessment results for James River segments are shown with both "old" assessment method (Arith Mean) and "new" assessment method (Geo mean). The 2008 Integrated Report uses monitoring data from 2004 through 2006. The 2010 Integrated Report uses monitoring data from 2006 through 2008. Only "old" method results are reported in the actual published Integrated Reports because "new' method is not yet formally adopted in WQS. Monitoring data used for both periods were combination of both dataflow and fixed site samples. Some segments/periods have a lot of dataflow data available (e.g. JMSPH for both 04-06 and 06-08 periods), others have much less or no dataflow data available (e.g. JMSTF for 06-08 period).

ATTACHMENT L

From Appendix M, Table M3 with only post processing for James LOE at 1/2 Potomac

'91 -'00 Base Scenario 36.8TN, 4.3TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	6%	6%	19%	11%	30%	16%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	9%	13%	16%	10%	13%
JMSMH	VA	30%	5%	0%	7%	13%	13%	8%	2%
JMSPH	VA	20%	5%	5%	22%	22%	22%	0%	0%

Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	35%	36%	20%	14%	2%	17%	22%	33%
JMSTFU	VA	22%	22%	17%	2%	18%	28%	28%	17%
JMSOH	VA	0%	0%	0%	0%	1%	1%	1%	0%
JMSMH	VA	0%	0%	0%	0%	4%	4%	28%	20%
JMSPH	VA	0%	0%	4%	6%	6%	0%	22%	33%

Tributary Strategy 27.5TN, 3.3TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	5%	5%	5%	0%	7%	7%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	7%	7%	7%	0%	6%
JMSMH	VA	4%	1%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%

Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	7%	20%	20%	10%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	18%	15%
JMSPH	VA	0%	0%	0%	0%	0%	0%	12%	12%

190/12.7 Loading Scenario 26.6TN, 2.7TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	2%	2%	2%	0%	0%	0%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	4%	4%	4%	0%	5%
JMSMH	VA	3%	1%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%

Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	5%	15%	15%	8%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	15%	14%
JMSPH	VA	0%	0%	0%	0%	0%	0%	11%	11%

James L.O.E 1/2 Potomac 23.5N 2.35P

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	1%	0%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%

Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	2%	6%	6%	2%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	1%	1%
JMSPH	VA	0%	0%	0%	0%	0%	0%	9%	9%

ATTACHMENT M

Adjusted Values Based on EPA June 2010 Presentation

'91 -'00 Base Scenario 36.8TN, 4.3TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	6%	6%	19%	11%	30%	16%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	9%	13%	16%	10%	13%
JMSMH	VA	30%	5%	0%	7%	13%	13%	8%	2%
JMSPH	VA	20%	5%	5%	22%	22%	22%	0%	0%
Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	35%	36%	20%	14%	2%	17%	22%	33%
JMSTFU	VA	22%	22%	17%	2%	16%	28%	28%	17%
JMSOH	VA	0%	0%	0%	0%	1%	1%	1%	0%
JMSMH	VA	0%	0%	0%	0%	4%	4%	28%	20%
JMSPH	VA	0%	0%	4%	6%	6%	0%	22%	33%

Tributary Strategy 27.5TN, 3.3TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	5%	5%	5%	0%	7%	7%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	7%	7%	7%	0%	6%
JMSMH	VA	4%	1%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%
Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	7%	20%	20%	10%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	5%	4%
JMSPH	VA	0%	0%	0%	0%	0%	0%	12%	12%

190/12.7 Loading Scenario 26.6TN, 2.7TP,

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	2%	2%	2%	0%	0%	0%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	4%	4%	4%	0%	5%
JMSMH	VA	3%	1%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%
Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	6%	14%	15%	8%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	4%	3%
JMSPH	VA	0%	0%	0%	0%	0%	0%	11%	11%

James L.O.E 1/2 Potomac 23.5N 2.35P

Cbseg	State	'91-'93 CL Spring Seasonal	'92-'94 CL Spring Seasonal	'93-'95 CL Spring Seasonal	'94-'96 CL Spring Seasonal	'95-'97 CL Spring Seasonal	'96-'98 CL Spring Seasonal	'97-'99 CL Spring Seasonal	'98-'00 CL Spring Seasonal
JMSTFL	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	1%	0%	0%	0%	0%	0%	0%	0%
JMSPH	VA	0%	0%	0%	0%	0%	0%	0%	0%
Cbseg	State	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal	CL Summer Seasonal
JMSTFL	VA	0%	0%	0%	0%	2%	6%	5%	2%
JMSTFU	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	VA	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	VA	0%	0%	0%	0%	0%	0%	1%	1%
JMSPH	VA	0%	0%	0%	0%	0%	0%	8%	9%

ATTACHMENT N

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CURRENT STATUS AND LONG-TERM TRENDS IN WATER QUALITY AND LIVING RESOURCES IN THE VIRGINIA TRIBUTARIES AND CHESAPEAKE BAY MAINSTEM FROM 1985 THROUGH 2007

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I. Introduction

The period prior to the implementation of the Chesapeake Bay Monitoring Program was characterized by a marked decline in the water quality of the Chesapeake Bay. The disappearance of submerged aquatic vegetation in certain regions of the Bay, declines in the abundance of some commercially and recreationally important species, increases in the incidence of low dissolved oxygen events, changes in the Bay's food web, and other ecological problems were related to deteriorating water quality (e.g. USEPA, 1982,1983;Officer et al.,1984; Orth and Moore, 1984). The results of concentrated research efforts in the late 1970s and early 1980s stimulated the establishment of Federal and state directives to better manage the Chesapeake Bay watershed. By way of the Chesapeake Bay Agreements of 1983, 1987 and 2000, the State of Maryland, the Commonwealths of Virginia and Pennsylvania, and the District of Columbia, agreed to share the responsibility for improving environmental conditions in the Chesapeake Bay. As part of these agreements, a long-term monitoring program of the Chesapeake Bay was established and maintained in order to: 1) track long-term trends in water quality and living resource conditions over time, 2) assess current water quality and living resource conditions, and 3) establish linkages between water quality and living resources communities. By tracking long-term trends in water quality and living resources, managers may be able to determine if changes in water quality and living resource conditions have occurred over time and if those changes are a reflection of management actions. Assessments of current status may allow managers to identify regions of concern that could benefit from the implementation of pollution abatement or management strategies. By identifying linkages between water quality and living resources it may be possible for managers to determine the impact of water quality management on living resource communities.

Water quality and living resource monitoring in the Virginia main stem and tributaries began in 1985 and continues to the present. Detailed assessments of the status and long-term trends in water quality and living resources in Chesapeake Bay and its tributaries have been previously conducted (Alden et al., 1991,1992; Carpenter and Lane, 1998; Dauer, 1997; Dauer et al., 1998a,1998b, 2002b; Lane et al.,1998; Marshall, 1994,1996; Marshall and Burchardt, 1998, 2003, 2004a, 2004b, 2005; Marshall et al., 1998;2005a;2005b;2006). This report summarizes the status of and long-term trends in water quality and living resource conditions for the Virginia tributaries through 2006 and updates the previous reports (Dauer et al., 2005a, 2005b, 2005c;2007).

II. Methods and Materials

A. Monitoring Program Descriptions

Non-tidal water quality samples were collected from 1988 through 2005 at six stations at or near the fall-line in each of the major tributaries as part of the U. S. Geological Survey's (USGS) and the Virginia Department of Environmental Quality's (DEQ) River Input Monitoring Program (Figure 1). Tidal water quality was regularly monitored at 28 sites in the Bay Mainstem and at 27 sites in the James, York and Rappahannock rivers (Figure 2) beginning in July, 1985 and continuing through 2006. Six permanent water quality monitoring sites were established in the Elizabeth River in 1989 and an additional six were added to the Elizabeth River in 1998 (Figure 2). Details of changes in the monitoring program sampling regime are provided elsewhere (Dauer et al., 2005a, 2005b, 2005c) while sample collection and processing protocols are provided on the World Wide Web at http://www.chesapeakebay.net/qualityassurance.aspx.

Phytoplankton monitoring was conducted at seven stations in the Chesapeake Bay Mainstem beginning in 1985 and at six sites in the major tributaries beginning in 1986 (Figure 3). Two phytoplankton monitoring programs stations (SBE5 and SBE2) were added in the Elizabeth River in 1989 although SBE2 was eventually discontinued. Epi-fluorescent autotrophic picoplankton and C^{14} primary productivity analysis were added to all stations in 1989. Details of changes in the monitoring program, field sampling and laboratory procedures are described by Dauer et al. (2005a, 2005b, 2005c).

Benthic monitoring was conducted at sixteen fixed point stations in the lower Chesapeake Bay Mainstem and its tributaries beginning in 1985. Sampling at five additional stations, two in the Elizabeth River and one in each of the three other tributaries, began in 1989 (Figure 3). Details of, and changes to, the fixed point monitoring program sampling regime and laboratory procedures are described by Dauer et al. (2005a, 2005b, 2005c).

In 1996, the benthic monitoring program was modified to add a probability-based sampling regime to supplement data collected at fixed-point stations and estimate the area of Chesapeake Bay and its tributaries that met restoration goals as indicated by the B-IBI (Ranasinghe et al., 1994; Weisberg et al., 1997; Alden et al., 2002). Data are collected at 25 randomly allocated stations in each of four separate strata in Virginia: 1) the James River, 2) the York River (including the Pamunkey and Mattaponi rivers), 3) the Rappahannock River, and 4) the Mainstem of the Chesapeake Bay. An additional set of 25 random locations have been collected in the Elizabeth River as a part of DEQ's Elizabeth River Monitoring Program beginning in 1999. Probability-based monitoring data are used to assess biological impairment in Chesapeake Bay at different spatial scales on an annual basis. Details of the sampling, laboratory and assessment protocols are provided in Dauer et al. (2005a,2005b,2005c) and Llansó et al. (2005). Further information on all of the monitoring programs can be found at www.chesapeakebay.net.

B. Statistical Analysis

Tabular summaries of land use coverages are modified from data provided by the USEPA's Chesapeake Bay Program. Discharged point source nutrients were obtained from the Central Office of the Virginia Department of Environmental Quality. A comparison of the relative importance of point and non-point sources was made by comparing estimates of discharged loadings of nutrients and sediments generated for the Year 2007 Progress Run of the Chesapeake Bay Watershed Model available on the WWW at www.chesapeakebay.net/data_modeling.aspx. Percent changes in these estimates over the last 22 years were made using 1985 Model Assessment Run values as a baseline.

To ensure that long-term trends in water quality and living resource data are correctly interpreted, a unified approach for conducting the statistical analyses was used based on guidelines developed by the CBP Monitoring Subcommittee's Tidal Monitoring and Assessment Workgroup. For both status and trend analyses, the stations were grouped into groups or segments based on the segmentation scheme developed by the Chesapeake Bay Program's Data Analysis Workgroup (Figure 2) and data were analyzed for different time periods or "seasons" as defined for each monitoring component in Table 1.

Status of all tidal water quality parameters except dissolved oxygen parameters for each Chesapeake Bay program segment was determined using two methods: 1) the relative status as described in Dauer et al. (2005a,2005b, 2005c), and 2) by comparing three year median values during the SAV growing season to SAV habitat criteria (see Table 2) using a Mann-Whitney U-test. Status of dissolved oxygen was determined by calculating the mean of the last three years (2005 through 2007) of bottom measurements collected during the Summer months (June through September) and classifying them as follows: mean values equal to or below 2 mg/L were classified as Poor, values between 2 and less than 5 mg/L were Fair, and values equal to or greater than 5 were Good. Note that the terms Good, Fair, and Poor used in conjunction with relative status are statistical classifications for comparison between areas of similar salinity within Chesapeake Bay. Though useful in comparing current conditions among different areas of Chesapeake Bay, these terms are not absolute evaluations but only appraisals relative to other areas of what is generally believed to be a degraded system.

Status characterizations for phytoplankton communities were determined using the phytoplankton Index of Biotic Integrity or P-IBI (Buchanan et al., 2005). Status was assessed using station means of the P-IBI for the three year period from 2004 through 2006. Phytoplankton communities were classified as follows: (1) Poor for P-IBI values less than or equal to 2.00; (2) Fair-Poor for values greater than 2.00 and less than or equal to 2.67; (3) Fair for values greater then 2.67 and less than or equal to 3.00; (4) Fair-Good for values greater than 3.00 and less than or equal to 4.00; and (5) Good for values greater than 4.00.

Status of benthic communities at each station was characterized using the three-year mean value (2005 through 2007) of the B-IBI (Weisberg et al., 1997) and classified as follows: values less than or equal to 2 were classified as severely degraded, values greater than 2.0 to 2.6 were classified as degraded, values greater than 2.6 but less than 3.0 were classified as marginal, and values of 3.0 or more were classified as meeting goals. Status of benthic communities was also quantified by using the probability-based sampling to estimate the bottom area of all strata populated by benthos classified as impaired using the B-IBI (Llansó et al., 2007).

Trend analyses of non-tidal water quality parameters used a seven parameter regression model that took into account the effects of flow, time, seasonal effects and other predictors conducted on flow-adjusted concentrations (Langland et al., 2006). Trend analyses of freshwater flow at the fall-line were conducted using a seasonal Kendall test for monotonic trends (Gilbert, 1987). Trend analyses of tidal water quality parameters in the tributaries were conducted using a "blocked" seasonal Kendall approach (Gilbert, 1987) for nutrients in order to account for method changes early in the program and using a seasonal Kendall test for monotonic trends and the Van Belle and Hughes tests for homogeneity of trends between stations, seasons, and station-season combinations for non-nutrient parameters in the tributaries and all water quality parameters in the Chesapeake Bay

Mainstem (Gilbert, 1987). Trend analyses of bottom dissolved oxygen measurements were conducted using only data collected during the Summer (June through September) season. Trend analyses for living resources used the Seasonal Kendall test.

III. Results and Discussion

A. James River Basin

1. Basin Characteristics

The James River basin has the largest population, the highest population density, the largest percentage of developed land, and the largest percentage of land with impervious surfaces of the three Virginia tributaries while at the same time having the highest total area and percentage of forested land, and the lowest percentage of agricultural land (Table 3A). Above the fall-line, the James River is predominantly rural with the dominant land use type being forest coupled with some agricultural lands. The tidal portion of the river is characterized by two large urbanized regions (Richmond and Hampton Roads) with high population densities, higher percentages of impervious surfaces, relatively lower forest cover and fewer riparian buffer miles separated by large areas of predominantly forest land and open water with some agricultural land (Table 3B).

Above the fall-line, model estimates of non-point sources accounted for over 90% of the 23,754,745 lb/yr of nitrogen loads and 86% of the 2,915,295 lb/yr of phosphorus loads entering the James River in 2007 (Table 4). Point source estimates accounted for 55% of the 25,253,407 lb/yr of the total nitrogen load entering the James River below the fall-line while non-point source loadings accounted for most (40%) of the 2,309,500 lb/yr of total phosphorus load (Table 4). Nutrient reduction activities are estimated to have resulted in 13% and 27% reductions in total nitrogen loading since 1985 above and below the fall-line, respectively (Table 4). These reductions were due primarily to reductions in non-point sources above the fall-line and point source loadings below the fall-line. Nutrient reductions activities resulted in a 17% and 56% reduction in total phosphorus loadings since 1985, above and below the fall-line, respectively (Table 4). Reductions above the fall-line were due to reductions in non-point source loadings while those below the fall-line were probably due to increased point source controls.

Annual discharged point source loadings of nitrogen were from five to seven times higher below the fall-line (BFL) than above the fall-line (AFL). Annual AFL point source loadings of total nitrogen have declined steadily from nearly 3,500,000 lb/yr in 1984 to just under 2,800,000 lb/yr in (Figure 4A). Following an initial increase from around 20,200,000 lb/yr in 1984 to over 25,000,000 lb/yr in 1989, BFL point source loadings declined substantially to stabilize at values of from 11,000,000 to 13,000,000 lb/yr during the last decade (Figure 4B).

Annual point source loadings of phosphorus were generally twice as high below the fall-line (BFL) than above the fall-line (AFL). AFL total phosphorus loadings were at or near 790,000 lb/yr prior to 1988 but declined sharply during the next two years to nearly 420,000 lb/yr in 1990. Following this decline point source phosphorus loads rose steadily to around 755,000 lb/yr in 2004 but have declined again substantially during the last two years to just over 400,000 lb/yr in 2006 (Figure 5).

2. Water Quality

There were no significant trends in freshwater flow in the James or Appomattox or Chickahominy rivers at the fall-line ($p > 0.01$; Seasonal Kendall test). In general, water quality above the fall-line in the James River appears to be improving as indicated by the decreasing trends in concentrations of nitrate-nitrites, total phosphorus and dissolved inorganic phosphorus parameters. No trends in nutrients or suspended solids were observed at the fall-line in the Appomattox or Chickahominy rivers (Table 5).

Relative status of most nutrients in the tidal James River was Good or Fair except with status generally being better in the upstream segments (Figure 6). Relative status of surface chlorophyll *a* was Good in all segments except the Appomattox River (APPTF) and the James River Mouth (JMSPH) where it was Poor and in the Chickahominy River (CHKOH) where it was Fair. Status of total suspended solids and Secchi depth was Fair or Poor throughout the James River but status of bottom dissolved oxygen was Good in all segments (Figure 7). Most long-term and post method change trends in nutrients observed indicated improving water quality conditions except in the Upper James River (JMSTF2) where degrading trends in surface and bottom total nitrogen were detected during the post-method change period and in the Lower James River where degrading trends in surface and bottom dissolved inorganic phosphorus were detected (Figure 6). Improving long-term trends in surface chlorophyll *a* were detected in the Chickahominy River (CHKOH) and the Upper James River (JMSTF1) but a degrading trend in this parameter was detected at the James River Mouth (JMSPH). Degrading trends in bottom total suspended solids were detected in the Upper James River (JSMTF2) and in the Lower James River (JMSMH) while degrading trends in secchi depth were detected in both segments of the Upper James River, the Chickahominy River (CHKOH), and at the James River Mouth (JMSPH). Improving trends in Summer bottom dissolved oxygen were detected in the Appomattox River (APPTF) and at the James River Mouth (JMSPH) (Figure 7).

SAV habitat requirements for nutrients, where applicable, were borderline or not met in all segments except in the Appomattox River (APPTF) and the Chickahominy (CHKOH) where the habitat requirement for surface dissolved inorganic phosphorus were met (Figure 8) SAV habitat requirements for surface chlorophyll *a* were met in all segments except in the Appomattox River (APPTF) where this parameter was borderline. SAV habitat requirements were not met or borderline for all segments for both surface total suspended solids and secchi depth except at the James River Mouth (JMSPH) were the requirement for surface total suspended solids was met (Figure 8). Degrading post method change trends were detected in surface total nitrogen and surface dissolved inorganic nitrogen in the Upper James River (JMSTF2) and the Chickahominy River (CHKOH) during the SAV growing season. Trend analysis indicated improvements in surface dissolved inorganic phosphorus in the Appomattox River and in the Upper James River (JMSTF2), however a degrading trend in this parameter was detected in the Lower James River (JMSPH). Improving trends in surface chlorophyll *a* were detected in the Upper James River (JMSTF1) and the Chickahominy River (CHKOH) during the SAV growing season. Although no trends were detected in total suspended solids, degrading trends in secchi depth were detected in all of the upper segments of the James River (APPTF, JMSTF2, JMSTF1 and CHKOH) as well as the James River Mouth (JMSPH). An improving trend in bottom dissolved oxygen was detected in the James River Mouth (JMSPH) during the SAV growing season (Figure 8).

Status of all nutrients was either Fair or Poor in throughout of the Elizabeth River except for surface and bottom dissolved inorganic nitrogen where it was Good (Figure 9). Status of chlorophyll *a* was Poor in the Western Branch (WBEMH) and Lafayette River (LAFMH), Fair in the Eastern Branch (EBEMH) and Elizabeth River main stem (ELIPH) and Good in the Southern Branch (SBEMH). Status for surface and bottom total suspended solids was Fair or Poor in all segments except for bottom total suspended solids in the Southern Branch (SBEMH) and Eastern Branch (EBEMH). Status of Secchi depth was Poor throughout the Elizabeth River while the status of dissolved oxygen was Good or Fair (Figure 10).

No significant trends in nutrients were detected in the Western Branch (WBEMH), or the Lafayette River (LAFMH). However improving trends in either surface and/or bottom total nitrogen and dissolved inorganic nitrogen were detected in the Southern Branch (SBEMH), the Eastern Branch (EBEMH) and the Elizabeth River Mainstem (ELIPH). Improving trends in surface and/or bottom total phosphorus and dissolved inorganic phosphorus were also detected in these two segments (Figure 9). A degrading trend in bottom total nitrogen was detected in the Elizabeth River Mainstem (ELIPH), as was a post method change improving trend in bottom dissolved inorganic nitrogen (Figure 9). There were no significant trends in chlorophyll *a* in the Elizabeth River. Improving trends in surface and bottom total suspended solids were observed in the Southern Branch (SBEMH), Eastern Branch (EBEMH) and Elizabeth River main stem (ELIPH). A degrading trend in Secchi depth was detected in the Elizabeth River Mainstem (ELIPH).

SAV habitat requirement for nutrients was not met or borderline in all segments of the Elizabeth River except in the Western Branch were surface dissolved inorganic nitrogen met the criterion (Figure 11). The SAV habitat requirement for chlorophyll *a* was met in most segments of the Elizabeth River. For surface total suspended solids, SAV habitat requirement was met in the Southern Branch (SBEMH) and Eastern Branch (EBEMH) but not met in the Western Branch. The SAV habitat requirement was borderline or not met in all segments for Secchi depth (Figure 11). Status of bottom dissolved oxygen during the SAV growing season was Good.

With respect to nutrients during SAV growing season, improving trends were observed in surface nitrogen parameters in the Southern Branch (SBEMH) and Eastern Branch (EBEMH) and for surface total phosphorus in the Southern Branch (SBEMH). Degrading trends in surface total and dissolved inorganic nitrogen were detected in the Elizabeth River Mainstem (ELIPH). An improving trend and a degrading trend in surface chlorophyll *a* were detected in the Southern Branch (SBEMH) and Eastern Branch (EBEMH), respectively. Although an improving trend in surface total suspended solids was detected in the Elizabeth River Mainstem (ELIPH), a degrading trend in Secchi depth was detected in the same segment.

3. Living Resources

Status of phytoplankton communities based on the P-IBI was classified as Fair to Poor at all stations in the James River and Elizabeth River and a degrading trend in the P-IBI was detected at station SBE5 in the Southern Branch of the Elizabeth River (Figure 12). Degrading trends in cyanobacteria abundance were also detected at nearly all stations in this basin along with degrading trends in primary productivity at station TF5.5 and the Margalef diversity index at station RET5.1. Improving trends in the biomass to abundance ratio were detected in all stations of the James River excluding station SBE5 in the Elizabeth River (SBEMH), as were improving trends in chlorophyte and picoplankton biomass at stations TF5.5 in the Upper James River (segment JMSTF1) and station RET5.1 in the Middle James River (JMSOH) (Figure 12). Two major concerns are indicated in this review. Both an upstream and a downstream station (TF5.5, LE5.5) indicated unfavorable increased biomass trends in cyanobacteria. This taxonomic group contains several major bloom produces and a few potentially toxic species. Their continued increased presence and biomass levels would be negative factors affecting water quality and biota in the James River. The second concern is the increased biomass trend in dinoflagellates downstream at station LE5.5. This group also contains several potential harmful species. This was evident in 2007 when major blooms of *Cochlodinium polykrikoides* occurred in the Elizabeth, Lafayette, and lower James rivers. Previous blooms of this species have been common in these rivers the past decade (Marshall et al., 2008) and have also taken place in August 2008. A similar negative trend in the lower James was the increased chlorophyll *a* levels accompanying this development.

The B-IBI met restoration goals at only two stations in the main stem of James River: station LE5.1 in the Middle James River (JMSOH) and, station LE5.4 in the Lower James River (JMSMH). Status of the B-IBI at all other stations in the James River was either degraded or marginal. Status of the B-IBI at both stations in the Elizabeth River was degraded (Figure 13). Improving trends in the B-IBI were detected at station RET5.2 in the Middle James River (JMSOH) and at stations SBE5 in the Southern Branch (SBEMH) of the Elizabeth River (Figure 13). In 2007, results of the probability-based benthic monitoring indicate that 68% of the total area of the James River is degraded (Llanso et al., 2007). Previous studies suggest that anthropogenic contaminant may account for much of the degradation in the James River particularly in the Elizabeth River (Dauer et al., 2005a; Llansó et al.,2005).

4. Management Issues

Trends at the fall-line indicate that in general water quality is improving in the non-tidal portions of the James River basin with respect to nutrient concentrations although no change in suspended solids was observed. Nutrients in the tidal portions of this estuary, although not as elevated as in other tributaries, do exceed desirable levels in some areas. Reductions in non-point source loadings as indicated by the reductions in fall-line nutrient concentrations above the fall-line coupled with declines in point sources loadings of nutrients both above and below the fall-line are probably linked to the high water quality with respect to nutrients found in the James River. These reductions coupled with naturally high freshwater flow input maintain nutrients at levels which are comparably better than many other areas in the Chesapeake Bay watershed. Despite the improvements, water clarity in the James River is consistently Poor and continues to decline in many areas of this tributary. The source of problems in water clarity is at least in part due to Poor conditions with respect to total suspended solids.

Despite the apparent improvements in water quality, living resources conditions in the James River are degraded and declining in some areas. Phytoplankton communities throughout the James River were characterized as Fair-Poor at all stations and conditions may be continuing to degrade as indicated by widespread degrading trends in cyanobacteria biomass although some improvements in phytoplankton communities were indicated. The benthos at most stations in the James River was marginal or degraded and probability-based benthic monitoring indicated that a high percentage (68%) of the total area of the river was degraded due in part to anthropogenic contamination (Llansó et al., 2008).

The Elizabeth River is highly impacted with respect to nutrients, water clarity and chlorophyll *a* in some areas. Intense urbanization resulting in high non-point source runoff coupled with high point source nutrient loadings result in the Poor water quality in this tributary. The degrading trends in the P-IBI in the Elizabeth River and the increasing trend in cyanobacteria biomass in the Elizabeth River are an important concern. At the level of the entire watershed, 72% of the river is characterized as having degraded benthos (Dauer, 2008). Although severely impaired, the Elizabeth River is improving at the upper reach station in the Southern Branch (SBE5). The primary stress to these communities appears to be anthropogenic contamination due to a variety of sources including historical contamination, municipal and industrial point sources, non-point source storm water run-off, and automobile emissions. Recent BMPs and reductions in point source loadings may be ameliorating both the problems with water quality and living resource conditions in some areas and expansion of these practices should result in further improvements.

B. York River Basin

1. Basin Characteristics

Although the York River watershed has the second highest total area and percentage of developed land and the second highest overall population density of all three of the Virginia tributaries, it is predominantly rural as indicated by the high percentages of forested and agricultural land with forested land accounting for over 60% of the total area. In addition, the York River has the highest percentages of open water and wetlands of all of the Virginia tributaries, as well as, the highest percentage of shoreline with a riparian buffer (Table 3A). Total area of developed land in all sub-watersheds of the York River was low and percent area of developed land was comparable between sub-watersheds. Total areas and percentages of impervious surface were always less than 3% of the total sub-watershed area. Total area and percentages of total sub-watershed area in agricultural land was generally higher in the upstream and non-tidal portions of the Pamunkey and Mattaponi rivers than in the tidal portion of the York River. Forested land decreases substantially moving downstream to the Lower Tidal York River both in total area and percent of the total sub-watershed area due primarily to an increase in open water (Table 3C).

Based on watershed model estimates, non-point sources accounted for 98% of the approximately 5,126,000 lb/yr of AFL total nitrogen loadings to the York River. There has been an estimated 16% reduction in AFL non-point source total nitrogen loadings while estimates of point source nitrogen loads increased 51% (Table 4). Non-point sources accounted for 76% of over 5,613,000 lb/yr of BFL total nitrogen loadings to the York River. Model estimates of non-point source BFL total nitrogen loads decreased 22% but point source nitrogen loadings increased 71%, respectively from 1985 through 2007 (Table 4).

Non-point sources accounted for 93% of nearly 512,500 lb/yr of the AFL total phosphorus loads and 74% of the BFL total phosphorus loads to the York River in 2007. Nutrient reduction strategies and the phosphate ban have resulted in an estimated overall reduction of 12% and 30% in non-point source loadings above and below the fall-line, respectively (Table 4). Estimates of point source loadings have increased 31% above the fall-line but decreased 54% below the fall-line (Table 4).

AFL point source loadings showed a general increase from around 112,000 lb/yr in 1984 to 213,000 lb/yr in 2000 followed by a mostly steady decline to approximately 128,000 lb/yr in 2006 (Figure 14A) BFL point source loadings of nitrogen initially declined from around 1,260,000 lb/yr in 1984 to approximately 650,000 in 1989. Thereafter, however, point source nitrogen loadings exceeded 1,000,000 lb/yr in 1990 and rose fairly steadily to reach a maximum of over 1,500,000 lb/yr in 1999 after which they dropped to below 1,000,000 lb/yr in 2001. However, during the last four years BFL point source nitrogen loadings increased steadily to reach a maximum of nearly 1,340,000 lb/yr in 2006 (Figure 14B).

AFL point source phosphorus loadings declined from approximately 37,500 lb/yr in 1984 to just under 25,000 lb/yr in 1991 but increased thereafter to reach a maximum of nearly 62,500 lb/yr in 2005. AFL point source phosphorus loadings declined sharply again in 2006 to approximately 34,000 lb/yr in 2006 (Figure 15A). BFL point source phosphorus loads declined from over 400,000 lb/yr in 1984 to 120,000 lb/yr in 1990 but then increasing to levels at or above 132,000 lb/yr until 2001 when loadings decreased to levels which have remained below 125,000 lb/yr (Figure 15B).

2. Water Quality

There were no trends in freshwater flow in either the Pamunkey or Mattaponi rivers ($p>0.01$; seasonal Kendall test). Water quality conditions at the fall-line in the Pamunkey River appear to be degrading as indicated by the increasing trends in flow adjusted concentrations of nitrogen and phosphorus parameters observed at the fall-line station near Hanover. No trends in water quality were detected at the fall-line in the Mattaponi River near Beulahville (Table 5).

Status of nitrogen parameters was Fair or Good in all segments. Status of phosphorus parameters was Good in the Upper Pamunkey River (PMKTF), the Upper Mattaponi River (MPNTF) and Mobjack Bay (MOBPH) but only Fair or Poor in the lower segments of the Pamunkey and Mattaponi (PMKOH and MPNOH) and the Lower York River (YRKPH). Status of phosphorus parameters in the Middle York River (YRKMH) was generally Poor (Figure 16). Status of surface chlorophyll *a* was Good in the Pamunkey River and Mattaponi River segments, but Fair in remaining segments. Status of total suspended solids was Poor or Fair in most segments except in the Upper Mattaponi River (MPNTF) where it was Good. Status of secchi depth was Poor in most segments of the York River except in the upper segments of Pamunkey and Mattaponi rivers where it was Fair and Good, respectively. Summer bottom dissolved oxygen status was Good or Fair in all segments (Figure 17).

Degrading long-term or post method change trends in surface and/or bottom nitrogen parameters were detected in all segments except Mobjack Bay (MOBPH) where improving trends in both total and dissolved inorganic nitrogen were detected. Degrading long term trends were detected in surface or bottom total phosphorus in the Upper and Lower Pamunkey River (PMKTF and PMKOH) and in the Middle York River (YRKMH) and Lower York River (YRKPH) while improving trends in both surface and bottom total phosphorus were detected in Mobjack Bay (MOBPH). Post method change improving trends in surface and bottom dissolved inorganic phosphorus were detected in the Upper Pamunkey River (PMKTF) and Upper Mattaponi River (MPNTF) while long-term degrading trends in surface and bottom dissolved inorganic phosphorus were detected in the Middle York River (YRKMH) (Figure 17). A degrading trend in surface chlorophyll *a* was detected in the Lower York River (YRKPH) while improving trends in bottom and/or surface total suspended solids were detected in the Upper Pamunkey River (YRKMH) and Mobjack Bay (MOBPH). Degrading trends in Secchi depth were detected in most segments (Figure 17)

SAV habitat requirements for nutrients in most segments were either met or were borderline except in the Middle York River (YRKMH) where the requirement for surface dissolved inorganic phosphorus was not met. Surface chlorophyll *a* met the SAV habitat requirement in all segments while surface total suspended solids did not meet the requirements in the Lower Pamunkey River (PMKOH), the Lower Mattaponi River (MPNOH), the Middle York River (YRKMH), and Mobjack Bay (MOBPH). Secchi depth was borderline or failed to meet the SAV criteria in most segments except the Upper Mattaponi (Figure 18). During the SAV growing season a degrading trend in surface total nitrogen was detected in the Lower York River while an improving post-method change trend was detected in Mobjack Bay (MOBPH). Degrading trends in phosphorus parameters were detected in the Lower Pamunkey River (PMKOH) and the Middle York River (YRKPH) while an improving trend was detected in the Upper Mattaponi River (MPNTF). However, an improving post-method change trend was detected in Mobjack Bay (MOBPH). There were no trends in surface chlorophyll *a* during the SAV growing season. Improving trends in surface total suspended solids were detected in the Lower Pamunkey River (PMKOH) and Mobjack Bay (MOBPH). Degrading trends in Secchi depth were detected in the Lower York River (YRKPH) and Mobjack Bay (MOBPH) (figure 18).

3. Living Resources

Status of the phytoplankton communities based on the P-IBI was Fair at station TF4.2 in the Upper Pamunkey River (PMKTF), Poor at station RET4.3 in the Middle York River (YRKMH) and Fair at station WE4.2 in Mobjack Bay (MOBPH) (Figure 19). There were no significant trends in the P-IBI. Improving trends in the biomass to abundance ratio and in chlorophyte abundance were detected at station TF4.2 in the Upper Pamunkey River (PMKTF) and at station RET4.3 in the

Middle York River (YRKMH). Degrading trends in primary productivity were detected at stations RET4.3 and WE4.2 and in cyanophyte biomass at all stations. A degrading trend in the Margalef diversity index was detected at station WE4.4 in Mobjack Bay (MOBPH) (Figure 19). Throughout the York River phytoplankton stations there were trends of increased cyanobacteria biomass. As noted in the James River, the cyanobacteria are represented by several potentially harmful taxa, some being toxin producers. Any further continuation of this trend is a potential water quality concern. In addition summer blooms of *Cochlodinium polykrikoides* continue to occur at downstream locations in the York and adjacent inlets. Many of these past blooms have lasted over several weeks, extending southward into the western coastal waters of Chesapeake Bay (Marshall et al. 2005b; 2008). An additional concern regarding the entry of other potentially toxic species in these waters occurred in 2007 when the toxic species *Alexandrium monilatum*, was identified during our monitoring in the lower York River and one of its sub-estuaries.

Benthic community status, as measured with the B-IBI, was Good only at station LE4.3 in the Lower York River (YRKPH) and either degraded or severely degraded at all other stations (Figure 20). An improving trend in the B-IBI was detected at station LE4.3B in the Lower York River (YRKPH) but no other trends in the B-IBI were detected (Figure 20). In 2007, results of the probability-based benthic monitoring indicate that 80% of the total area of the York River was degraded (Llansó et al.,2008). Previous studies indicate that a combination of anthropogenic contamination, eutrophication and low dissolved oxygen adversely affect benthic communities in the York River (Dauer et al., 2005b; Llansó et al.,2005).

4. Management Issues

Water quality in the non-tidal portion of the Pamunkey River appears to be degrading as indicated by increasing trends observed in both nitrogen and phosphorus parameters. Despite the generally Good relative status, increasing trends in both nitrogen and to a lesser degree phosphorus parameters indicate that water quality in the York River may be degrading possibly in response to increases in above fall-line non-point source loadings. In addition, degrading trends in nutrients may be due to increasing point source total nitrogen loads both above and below the fall-line and to increasing AFL point source total phosphorus loads. Poor water clarity is a persistent and widespread problem in the York River as indicated by the Poor relative status, the SAV habitat requirement failures of secchi depth throughout the estuary and the degrading trends observed in some segments. The source of the water clarity problem is unknown. Although the increases in point source nutrients observed were relatively small, the small total area and low flow rates of the York River may make it more susceptible to changes in point or non-point source nutrient loadings.

Phytoplankton community conditions appear to reflect Poor water quality conditions as indicated by the Fair to Poor status in the P-IBI observed through this tributary. In addition, phytoplankton communities may be continuing to degrade as indicated by the increasing trends in cyanobacteria biomass. The increases in cyanobacteria observed may adversely affect water clarity. Although sporadic in their occurrence, dinoflagellate blooms occur in the downstream areas of this tributary and are often extensive in areal coverage and in the duration of their development. On these occasions, they represent a serious negative effect on water quality and living resources of the area.

All but one of the fixed point benthic monitoring stations in the York River were degraded and probability-based sampling indicated that 80% of the bottom of the York River does not met the restoration goals (Llansó et al.,2008). Previous studies suggest that anthropogenic contamination appears to be the predominant source of stress to the benthos but eutrophication and low dissolved oxygen also play a role (Dauer et al., 2005b). There is a possibility that physical disturbance of the benthos caused by seabed mixing, a natural source of stress, may also be an important factor determining benthic community status in the York River (Dellapenna et al., 1998; 2003).

C. Rappahannock River Basin

1. Basin Characteristics

The Rappahannock River is predominantly rural with lowest overall population density and percentage of developed land of all three Virginia tributaries coupled with high percentages of agricultural and forest land use types. It has the second highest area of agricultural cropland of all three of the Virginia tributaries (Table 3A). Sub-watershed specific percentages of agricultural land were generally near or greater than 20% and decreased moving downstream from above the fall-line while percentages of forest land were above 40% and also decreased moving downstream. The percentage of shoreline with a riparian buffer was 35.6% overall and decreased moving downstream from the Upper Tidal portion of the river (Table 3D).

Non-point sources are estimated to have accounted for 95% of the nearly 5,900,000 lb/yr of total nitrogen loads above the fall-line and 92% of the nearly 4,000,000 lb/yr below the fall-line. Although the AFL point source nitrogen loads increased 43% from 1985 through 2007, non-point source loadings were reduced 17% resulting in a 16% reduction in total nitrogen above the fall-line (Table 4).

Based on model estimates, non-point sources accounted for 95% of the 579,000 lb/yr of AFL total phosphorus loads and 92% of the 306,000 lb/yr of BFL total phosphorus loads to the Rappahannock River. Management activities resulted in estimates reductions of 18% and 38% in non-point source loading above and below the fall-line, respectively (Table 4). Estimates of point source loadings decreased 60% and 79% above and below the fall-line, respectively (Table 4).

AFL point source loadings of nitrogen initially decreased overall from over 190,000 lb/yr in 1984 to 135,000 lb/yr in 1988. After this time AFL point source loadings showed a generally increasing trend to a value just over 260,000 lb/yr in 2007 (Figure 21A). In contrast, BFL total nitrogen loads showed a general increase from over 330,000 lb/yr in 1984 to nearly 470,000 lb/yr in 1989. Thereafter values typically maintained levels above 300,000 lb/yr during the period from 1990 through 2003 but thereafter declined to around 232,000 lb/yr in 2007 (Figure 21B).

Annual BFL point source loadings of phosphorus were typically higher than AFL values for the period of 1985 through 1995 but have become comparable during the last eight years following substantial and generally steady declines in both regions that began in 1989 following the phosphate ban (Figure 22A-B). AFL point source loadings of total phosphorus showed a decline from an initial

81,000 lb/yr in 1984 to about 26,000 lb/yr in 2007 (Figure 22A). BFL point source loadings of total phosphorus showed a steep drop from values at or above 115,000 lb/yr from 1984 through 1987 to just over 66,000 lb/yr in 1988. Thereafter, BFL point source total phosphorus loads have steadily declined to less that 20,000 lb/yr in the Rappahannock River (Figure 22B).

2. Water Quality

No significant trends in freshwater flow at the Rappahannock River fall-line were detected. There were no significant trends in nutrient or total suspended solids above the fall-line in the Rappahannock River (Table 5).

Relative status of nutrients was Good for all parameter/segment combinations in the Rappahannock River except for surface and bottom total phosphorus in the Middle Rappahannock River (RPPOH) where it was Fair (Figure 23). Status of chlorophyll *a* was Fair in all segments except the Upper Rappahannock River (RPPTF) where it was Good. Status of surface and bottom total suspended solids was Fair or Poor except in the Corrotoman River (CRRMH) where it was Good. Status of Secchi depth was Poor in all segments of the Rappahannock River except for the Corrotoman River (CRRMH) where it was Fair. Status of Summer bottom dissolved oxygen was Good in Upper Rappahannock River and the Middle Rappahannock River and Fair in the remaining segments Figure 24).

Degrading long-term trend were detected in bottom total nitrogen and surface total phosphorus in the Middle Rappahannock River (RPPOH) and in surface total phosphorus in the Corrotoman River (CRRMH). An improving long-term trend in surface dissolved inorganic nitrogen was detected in the Corrotoman River (CRRMH). Improving post method change trends were detected in surface and/or dissolved inorganic phosphorus in the Upper Rappahannock River (RPPTF) and the Middle Rappahannock River (RPPOH) (Figure 23). Degrading trends in surface chlorophyll *a* were detected in the Middle Rappahannock River (RPPOH) and Lower Rappahannock River (RPPMH). Although there were no trends in total suspended solids, degrading trends in secchi depth were also detected in the Middle Rappahannock River (RPPOH) and the Corrotoman River (CRRMH). Decreasing trends in salinity were detected in the Lower Rappahannock River (RPPMH) and the Corrotoman River (CRRMH) (Figure 24).

SAV habitat requirements for nutrients were met in all applicable segments. Surface chlorophyll *a* was either borderline or met the SAV habitat criteria throughout the Rappahannock River. Both surface total suspended solids and secchi depth failed to meet the SAV habitat criteria in both the Upper Rappahannock River (RPPOH) and the Middle Rappahannock River (RPPMH) but were borderline or met the criteria elsewhere. During the SAV growing season, a improving long-term trend in surface dissolved inorganic nitrogen was detected in the Corrotoman River (CRRMH) as well as degrading trends in surface chlorophyll *a* in the Middle Rappahannock River (RPPOH) and the Lower Rappahannock River (RPPMH). Degrading trends in secchi depth were observed in Lower Rappahannock River (RPPMH) and the Corrotoman River (CRRMH) (Figure 24).

3. Living Resources

Status of phytoplankton communities based on the P-IBI was Fair at station LE3.6 and Fair-Poor at station RET3.1 in the Lower Rappahannock River (RPPMH) while status was Poor at station TF3.3 also in the Middle Rappahannock River (RPPOH). There were no significant trends in the P-IBI. Improving trends in the biomass to abundance ratio were detected at all stations while degrading trends in primary productivity and cyanophyte biomass were detected at all stations. Improving trends in diatom and chlorophyte biomass were detected at station TF3.3 in the Middle Rappahannock River and station RET3.1 in the Lower Rappahannock River (RPPMH) along with an improving trend in picoplankton biomass at station LE3.6 in the Lower Rappahannock River (RPPMH). A degrading trend in the Margalef diversity index was also detected at this station. In addition to the trend of increased cyanobacteria biomass at all stations there were also increasing trends in dinoflagellate biomass. These two categories each contain potentially harmful and toxic species. Of concern would be the continuous increased biomass of these two groups and a decline in diatom biomass which presently indicated no significant trend. These increasing biomass trends were accompanied by increasing chlorophyll *a* levels.

Benthic community status met the restoration goals only at station TF3.3 in the Middle Rappahannock River (RPPOH) and in general became more degraded moving downstream with both stations in the Lower Rappahannock River (RPPMH) being severely degraded. A degrading trend in the B-IBI was detected at station RET3.1 in the Lower Rappahannock River (RPPMH) (Figure 26). Probability-based benthic monitoring results indicated that 88% of the total area of the Rappahannock River was impaired in 2007. Previous studies indicate benthic degradation in the Upper Rappahannock River appears to be the result of anthropogenic contamination while degradation in the lower segments of the river may be the result of a combination of contamination and low dissolved oxygen effects (Dauer et al., 2005c; Llansó et al.,2005).

4. Management Issues

Water quality conditions with respect to nutrients are generally Good through the Rappahannock River. Water quality problems with non-nutrient parameters were more severe in the upper tidal regions of the Rappahannock River and include Poor status and violations of SAV habitat criteria for both suspended solids and secchi depth. Water clarity may also be degrading in the lower portion of the river as evidences decreasing trends in secchi depth observed. Issues with phytoplankton communities include Poor status and degrading trends in cyanophyte biomass and primary productivity throughout the basin, as well as, Poor status and degrading trends in Margalef species diversity and dinoflagellate abundance in the lower river. The pattern of increasing trends in cyanophyte biomass is exhibited not only in each of the Virginia rivers mentioned in this report, but also the Potomac River located north of the Rappahannock River. Already major blooms of cyanobacteria occur annually in the Potomac. If the increasing trends among the cyanobacteria continue, management concerns will include the impact of any long term, extensive development of these taxa within Virginia rivers. Several of the cyanobacteria identified in Virginia rivers are potential toxin producers. One of the most common species is *Microcystis aeruginosa*, which to date has not produced major toxic blooms in the James, York, or Rappahannock Rivers, but has been associated with blooms and the toxin microcystin in several of the Virginia bays and streams bordering the Potomac River.

Status of benthic communities for fixed point monitoring stations was degraded at stations furthest downstream in the Rappahannock River probably as a result of the low dissolved oxygen in this region. Degrading trends were detected in B-IBI at the uppermost station of Lower Rappahannock River (RPPMH). In 2007, results of the probability-based monitoring results indicate that 88% of the total area of the tidal portion of the river is degraded (Llansó et al.,2008).

D. Virginia Chesapeake Bay Mainstem

1. Water Quality

Relative status of nutrients was Good for all nutrient parameter/segment combinations in the Virginia Chesapeake Bay Mainstem except for bottom total nitrogen in Pocomoke Sound (POCMH) and bottom dissolved inorganic nitrogen in the Lower Western Mainstem (CB6PH) where the status of these parameters was Fair (Figure 28). Status was of surface chlorophyll *a* was Fair in all segments but the Lower Mainstem (CB8PH) and Pocomoke Sound (POCMH) where it was Good and Poor, respectively. Status of surface and bottom total suspended solids was Good in most segments except in the Lower Eastern Mainstem (CB7PH) were status of bottom total suspended solids was Fair and in Pocomoke Sound where status of surface and bottom suspended solids was Poor and Fair, respectively. Status of Secchi depth was Fair or Poor in all segments while status of bottom dissolve oxygen was Good in all segments except the Lower Western Mainstem where it was Fair (Figure 29).

Improving trends in surface and/or bottom total nitrogen where detected during the post-method change period in all segments of the Virginia Chesapeake Bay Mainstem except the Lower Mainstem (CB8PH). Degrading post-method change trends in surface and bottom total dissolved inorganic nitrogen were detected in the Lower Mainstem (CB8PH) while improving post-method change trends in surface and bottom dissolved inorganic nitrogen were detected in Pocomoke Sound (POCMH). Improving post-method change or long-term trends in surface and/or bottom total phosphorus were detected in all segments. There were no trends in surface dissolved inorganic phosphorus except for a post-method change improving trend in bottom dissolved organic phosphorus in Pocomoke Sound (POCMH) (Figure 28). There were no significant trends in surface chlorophyll *a* in any segments. Improving trends in both surface and bottom total suspended solids were detected in the Piankatank River (PIAMH), the Lower Western Mainstem (CB6PH), and Pocomoke Sound (POCMH) while degrading trends in these two parameters were detected in the Lower Eastern Mainstem (CB7PH). Decreasing trends in both surface and bottom salinity were detected in all segments of the Virginia Chesapeake Bay Mainstem (Figure 29).

SAV habitat requirements for nutrients, surface chlorophyll a, surface total suspended solids and Secchi depth were met in all applicable segments except in the Piankatank River where Secchi depth was borderline and in Pocomoke Sound where surface total suspended solids was borderline and Secchi depth failed to meet the criterion (Figure 30). Relative status for all nutrients was Good for most segments except in Pocomoke Sound (POCMH) where the status of surface total nitrogen was Fair. Status was Fair in most segments for chlorophyll *a* and Good in most segments for surface total suspended solids. Status of Secchi depth was Poor in all but two segments where it was Fair (Figure 30). Improving post-method change trends in surface total nitrogen were detected in all segments except the Lower Mainstem (CB8PH). Improving long-term or post-method change trends in surface total phosphorus were detected in all segments except the Piankatank River (PIAMH). An improving trend in surface total suspended solids was detected in the Piankatank River (PIAMH) while degrading trends in Secchi depth were detected in all segments (Figure 30).

2. Living Resources

Status of phytoplankton communities in the Virginia Chesapeake Bay Mainstem based on the P-IBI was Fair at stations CB6.1, CB6.4 in the Lower Western Mainstem (CB6PH) and CB7.3E in the Lower Eastern Mainstem (CB7PH) and Fair-Good at station CB7.4 in the Lower Mainstem (CB8PH) (Figure 31). There were no significant trends detected in the P-IBI. Improving trends were detected in the biomass to abundance ratio at all stations except CB6.1 and in picoplankton abundance at stations CB6.1 and CB6.4 in the Lower Western Mainstem (CB6PH). Degrading trends were detected in the Margalef diversity index, primary productivity and dinoflagellate abundance at stations CB6.4 in the Lower Western Mainstem (CB6PH) and station CB7.4 in the Lower Mainstem (CB8PH). Degrading trends in cyanophyte biomass at all stations as well as degrading trends in dinoflagellate biomass at two stations (Figure 31) raises concern about blooms of potentially harmful taxa in the lower Bay ecosystem. Both of these groups represent less favorable taxa relative to the health status of the Bay. Current monitoring has to date identified a total of 37 potentially harmful species within the Chesapeake Bay and its tidal tributaries (Marshall et al.,2005a; 2005b; 2008).

Status in benthic communities at the fixed point stations was severely degraded at station CB5.4, marginal at station CB6.1and Good at all remaining stations in the Virginia Chesapeake Bay Mainstem (Figure 32). Probability-based benthic monitoring results for 2007 indicated that 32% of the total area of the Virginia Chesapeake Bay Mainstem was impaired (Llansó et al.,2008).

3. Management Issues

Nutrient conditions in the Virginia Chesapeake Bay Mainstem appear to be Good both with respect to relative status and with respect to SAV habitat requirements and also to be improving as evidenced by the decreasing trends in both total nitrogen and total phosphorus observed in all segments. Although relative status of total suspended solids was typically only Fair or Poor improving trends in this parameter were observed in several segments and the SAV criterion for this parameter was met in most segments. However, water clarity, as measured using Secchi depth, appears to be an important water quality problem in the Mainstem as relative status was only Poor or Fair in this region and degrading trends in the parameter were detected in all segments.

With respect to living resources, the Virginia Chesapeake Bay Mainstem was the least impacted of Virginia's tidal water regions. Phytoplankton community status, as measured phytoplankton P-IBI was Fair-Good at all stations. However, there are some indications that phytoplankton communities may be degrading as indicated by the increasing trends in productivity, decreasing trends in species diversity and increasing trends in cyanobacteria and dinoflagellate biomass found at several stations. With respect to the benthos, the B-IBI met the restoration goal at most stations and only 32% of the total area of Virginia Chesapeake Bay Mainstem was classified as impaired. No trends were observed for the B-IBI. Good water quality and living resource conditions coupled with the improving trends in both water quality and living resources observed suggest that reductions in both point and non-point source loadings that have occurred over the last twenty years may have resulted in improvements within the Mainstem.

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Tables

Table 1. Definitions of seasonal time periods for status and trend analyses conducted for of the tidal monitoring programs. A "x" indicates the analysis was conducted for the season and parameter group combination while a "-" indicates that no analysis was conducted. Benthic status and trend analyses were conducted on data collected from July 15 through September 30*.

		Water Quality			Plankton		Benthos	
Season	Definition	Status	Trend	SAV Goals	Status	Trend	Status	Trend
Annual	Entire year	x	x	-	x	x	-	-
SAV1	March through May and September through November	x	x	x	x	x	-	-
SAV2	April through October	x	x	-	x	x	-	-
Summer1	June through September	x	x	-	x	x	-	-
Summer2	July through September	x	x	-	x	x	x*	x*
Spring1	March through May	x	x	-	x	x	-	-
Spring2	April through June	x	x	-	x	x	-	-
Fall	October through December	-	x	-	x	x	-	-
Winter	January and February	-	x	-	x	x	-	-

Table 2. Habitat requirements for growth and survival of SAV (from Batiuk et al., 1992; 2000).

Salinity Regime	SAV Growth Season	Secchi Depth (m)	Total Suspended Solids (mg/l)	Chlorophyll *a* (µg/l)	Dissolved Inorganic Nitrogen (mg/l)	Dissolved Inorganic Phosphorus (mg/l)
Tidal Freshwater	Apr.-Oct.	<2	<15	<15	none	<0.02
Oligohaline	Apr.- Oct.	<2	<15	<15	none	<0.02
Mesohaline	Apr.-Oct.	<1.5	<15	<15	<0.15	<0.01
Polyhaline	Mar.-May, Sep.-Nov.	<1.5	<15	<15	<0.15	<0.01

Table 3. Comparison of land use and population patterns between A. Watersheds of the Virginia portion of Chesapeake Bay, B. Sub-watersheds of the James River, C. Sub-watersheds of the York River and D. Sub-watersheds of the Rappahannock River. Land use values are expressed as the total area in km^2 within each watershed or sub-watershed and in parentheses as percentages of the total area within the watershed or sub-watershed. Note that the Impervious Surface land use category encompasses portions of the other land use types. Riparian buffers are measured in km of shoreline with a 30 m riparian buffer. Population values are provided as both total number per watershed or sub-watershed and densities expressed in the number of individuals per km^2. All land use and population data presented were obtained and modified from data provided by the USEPA's Chesapeake Bay Program.

A. Watersheds of the Virginia portion of Chesapeake Bay

	Land Use Area in km^2 (percent of total)									
Watershed	Total Area	Developed	Agriculture	Forested	Open Water	Wetland	Barren	Impervious Surfaces	Riparian Buffers (%)	Pop. Number/ Density(#/km^2)
Chesapeake Bay	171,944	6,239(3.6)	48,938(28.5)	103,343(60.1)	7,415(4.3)	4,421(2.6)	1,551(0.9)	3,026(1.8)	110,134 (58.5)	15,594,241(91)
James River	27,019	1,222(4.5)	4,605(17.0)	19,119(70.8)	989(3.7)	704(2.6)	365(1.4)	511(1.9)	16,636(60.2)	2,522,583(93)
York River	8,469	192(2.3)	1,761(20.8)	5,159(60.9)	647(7.6)	575(6.8)	135(1.6)	81(1.0)	6,062(60.3)	372,488(44)
Rappahannock River	7,029	124(1.8)	2,207(31.4)	4,009(57.0)	443(6.3)	171(2.4)	75(1.1)	46(0.7)	3,672(35.6)	240,754(34)

B. Sub-watersheds of the James River

	Land Use Area in km^2 (percent of total)									
Subwatershed	Total Area	Developed	Agriculture	Forested	Open Water	Wetland	Barren	Impervious Surfaces	Riparian Buffers (%)	Pop. Number/ Density(#/km^2)
AFL Upper James	7,938	67(0.8)	1158(14.6)	6630(83.5)	44(0.6)	10(0.1)	26(0.3)	24(0.3)	4427(40)	313780(40)
AFL North of Hopewell	642	171(26.6)	127(19.8)	280(43.5)	31(4.8)	18(2.8)	16(2.4)	68(10.6)	359(33)	367126(572)
AFL Piedmont	12,362	184(1.5)	2173(17.6)	9438(76.3)	114(0.9)	212(1.7)	243(2.0)	49(0.4)	8061(40)	186360(15)
AFL Richmond	790	91(11.5)	179(22.6)	461(58.4)	23(3.0)	28(3.6)	8(1.0)	30(3.8)	478(37)	60550(77)
AFL Swift Creek	471	21(4.4)	60(12.6)	376(79.7)	8(1.6)	3(0.5)	5(1.1)	10(2.1)	346(43)	188746(400)
AFL Upper Chickahominy	787	137(17.4)	148(18.8)	394(50.0)	10(1.3)	91(11.5)	8(1.0)	49(6.3)	739(32)	85669(109)
Appomattox	212	47(22.0)	44(20.7)	101(47.6)	5(2.4)	8(2.7)	8(3.7)	19(9.0)	121(32)	84765(399)
Lower Chickahominy	430	5(1.2)	52(12.0)	277(64.5)	39(9.0)	52(12.0)	5(1.2)	2(0.4)	537(34)	10343(24)
Upper Tidal James	730	18(2.5)	135(18.4)	445(61.0)	93(12.8)	31(4.3)	5(0.7)	9(1.2)	419(34)	36769(50)
Middle Tidal James	368	13(3.5)	62(16.9)	168(45.8)	96(26.1)	28(7.7)	3(0.7)	7(1.9)	311(35)	39886(108)
Lower Tidal James	803	73(9.0)	137(17.1)	256(31.9)	272(33.9)	62(7.7)	5(0.6)	30(3.8)	371(26)	166367(207)
Nansemond	559	28(5.1)	181(32.4)	197(35.2)	60(10.6)	85(15.3)	10(1.9)	14(2.5)	248(22)	49578(89)
Elizabeth River/Hampton Roads	668	259(38.8)	114(17.1)	52(7.8)	163(24.4)	67(10.1)	13(1.9)	141(21.1)	74(9)	594760(890)

Table 3. Continued. Land use values are expressed as the total area in km^2 within each watershed or sub-watershed and in parentheses as percentages of the total area within the watershed or sub-watershed. Note that the Impervious Surface land use category encompasses portions of the other land use types. Riparian buffers are measured in km of shoreline with a 30 m riparian buffer. Population values are provided as both total number per watershed or sub-watershed and densities expressed in the number of individuals per km^2. All land use and population data presented were obtained and modified from data provided by the USEPA's Chesapeake Bay Program.

C. Sub-watersheds of the York River

	Land Use Area in km^2 (percent of total)									
Sub-watershed	Total Area	Developed	Agriculture	Forested	Open Water	Wetland	Barren	Impervious Surfaces	Riparian Buffers (%)	Pop. Number/ Density(#/km^2)
Above Fall-Line Pamunkey	2748	31(1.1)	645(23.5)	1870(68.0)	67(2.5)	75(2.7)	62(2.3)	11(0.4)	1720(65)	55111(20)
Upper Pamunkey	785	21(2.6)	243(31.0)	425(54.1)	13(1.7)	67(8.6)	13(1.7)	6(0.8)	686(74)	33911(43)
Lower Pamunkey	282	3(0.9)	44(15.6)	150(53.2)	31(11.0)	49(17.4)	5(1.8)	1(0.5)	189(38)	3696(13)
Above Fall-Line Mattaponi	1023	16(1.5)	199(19.5)	717(70.1)	10(1.0)	52(5.1)	23(2.3)	13(1.3)	816(81)	32564(32)
Upper Mattaponi	805	3(0.3)	179(22.2)	541(67.2)	10(1.3)	54(6.8)	16(1.9)	2(0.3)	774(87)	8430(10)
Lower Mattaponi	534	5(1.0)	111(20.9)	350(65.5)	23(4.4)	47(8.7)	3(0.5)	2(0.4)	482(67)	7577(14)
Upper Tidal York	523	10(2.0)	80(15.3)	293(55.9)	91(17.3)	47(8.9)	3(0.5)	5(1.0)	376(53)	23676(45)
Lower Tidal York	215	10(4.8)	26(12.0)	78(36.1)	85(39.8)	13(6.0)	0(0)	5(2.2)	91(31)	21072(98)
Mobjack Bay	671	10(1.5)	88(13.1)	272(40.5)	205(30.5)	93(13.9)	5(0.8)	5(0.7)	270(27)	24929(37)

D. Sub-watersheds of the Rappahannock River

	Land Use Area in km^2 (percent of Sub-watershed total)									
Sub-Watershed	Total Area	Developed	Agriculture	Forested	Open Water	Wetland	Barren	Impervious Surfaces	Riparian Buffers (%)	Pop. Number/ Density(#/km^2)
AFL Rappahannock	4035	57(1.4)	1466(36.3)	2463(61.0)	16(0.4)	10(0.3)	28(0.7)	16(0.4)	1470(32.2)	101306(25)
Upper Tidal Rappahannock	878	41(4.7)	223(25.4)	521(59.3)	31(3.5)	47(5.3)	16(1.8)	21(2.4)	682(41.3)	97960(112)
Middle/Lower Rappahannock	982	16(1.6)	282(28.8)	502(51.2)	85(8.7)	80(8.2)	16(1.6)	5(0.5)	825(38.7)	12373(13)
Lower Rappahannock	694	8(1.1)	155(22.4)	339(48.9)	155(22.4)	28(4.1)	13(1.9)	3(0.4)	449(37.2)	10480(15)
Mouth of Rappahannock	440	8(1.8)	80(18.2)	184(41.8)	155(35.3)	8(1.8)	5(1.2)	2(0.5)	244(32.0)	10786(24)

Table 4. Nutrient and Sediment A. Non-point Source Loadings, B. Point Source Loadings and C. Total Loadings for Virginia tributaries for 2007, modified from data retrieved from the Chesapeake Bay Program Model Output Database (www.chesapeakebay.net/data_modeling.aspx). Nitrogen and phosphorous loads are in pounds per year while sediment loads are tons per year. Percent changes compare 2007 Progress Run values to the 1985 Model Assessment Run values. All loads presented are model estimates of discharged or "end of stream" loads.

A. Non point Sources

Basin	Location	2007 Nitrogen Loads (lbs/yr)	% Change	2007 Phosphorus Loads (lbs/yr)	% Change	2007 Sediment Loads (tons/yr)	% Change
James	AFL	21,909,750	-12	2,585,439	-14	594,541	-20
	BFL	11,314,454	-6	1,378,232	-16	128,133	-8
York	AFL	5,000,624	-16	478,857	-12	214,494	-19
	BFL	4,274,430	-22	341,848	-30	70,422	-28
Rappahannock	AFL	5,623,898	-17	550,832	-18	92,758	-20
	BFL	3,667,689	-28	280,919	-38	123,698	-36

B. Point Sources

Basin	Location	2007 Nitrogen Loads (lbs/yr)	% Change	2007 Phosphorus Loads (lbs/yr)	% Change
James	AFL	1,844,996	-25	329,856	-34
	BFL	13,938,953	-38	931,268	-74
York	AFL	125,643	51	33,591	31
	BFL	1,338,599	71	117,455	-54
Rappahannock	AFL	272,467	43	28,341	-60
	BFL	310,684	-11	25,359	-79

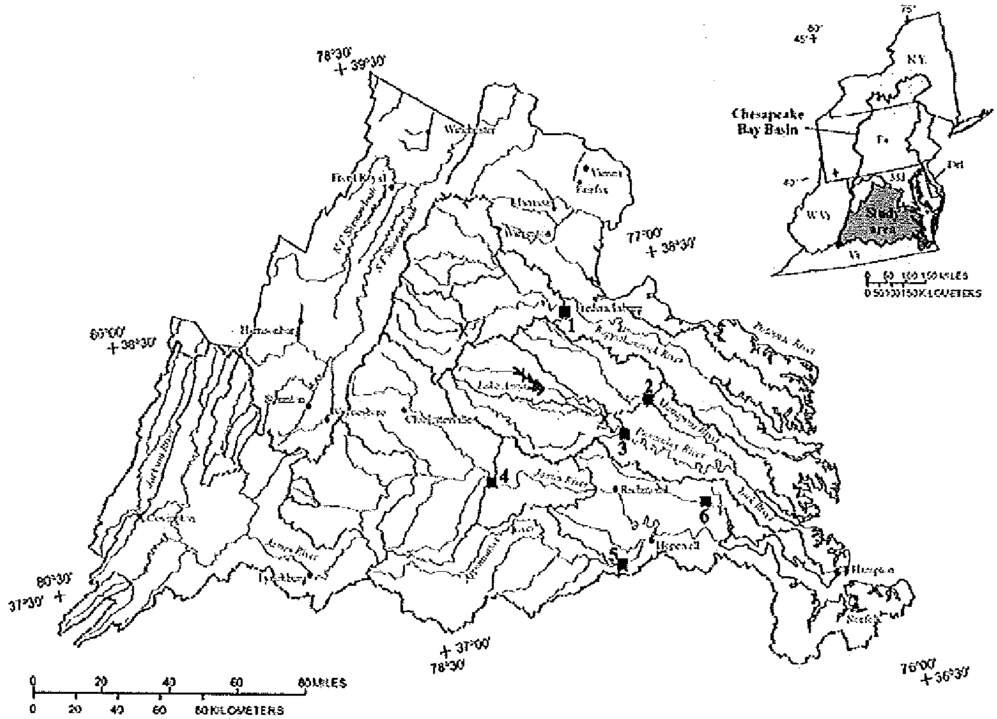
C. Total

Basin	Location	2007 Nitrogen Loads (lbs/yr)	% Change	2007 Phosphorus Loads (lbs/yr)	% Change	2007 Sediment Loads (tons/yr)	% Change
James	AFL	23,754,745	-13	2,915,295	-17	594,541	-20
	BFL	25,253,407	-27	2,309,500	-56	128,133	-8
York	AFL	5,126,267	-15	512,448	-10	214,494	-19
	BFL	5,613,029	-10	459,301	-38	70,422	-28
Rappahannock	AFL	5,896,364	-16	579,173	-22	92,758	-20
	BFL	3,978,374	-27	306,278	-47	123,698	-36

Table 5. Long-term trends in nutrients and total suspended solids at Chesapeake Bay River Input Monitoring Program stations located at or near the fall-line for each of the major Virginia tributaries for the period of 1984 through 2007. Results provided and modified from U.S. Geological Survey.

Station	Station Name	Parameter	Flow Adjusted τ Statistic	P value	Flow Adjusted % Change	Direction
02035000	James River at Cartersville	TN	-0.2598	<0.0001	-22.9	Improving
02035000	James River at Cartersville	DNO23	-0.4302	<0.0001	-35	Improving
02035000	James River at Cartersville	TP	-0.9081	<0.0001	-59.7	Improving
02035000	James River at Cartersville	DIP	-1.7364	<0.0001	-82.4	Improving
02035000	James River at Cartersville	TSS	-0.2607	0.0306	-22.9	Improving
02041650	Appomattox River at Matoaca	TN	0.0087	0.8626	0.9	No Trend
02041650	Appomattox River at Matoaca	DNO23	-0.2008	0.0968	-18.2	No Trend
02041650	Appomattox River at Matoaca	TP	0.2048	0.0123	22.7	No Trend
02041650	Appomattox River at Matoaca	DIP	-0.215	0.0309	-19.3	No Trend
02041650	Appomattox River at Matoaca	TSS	-0.067	0.4592	-6.5	No Trend
01673000	Pamunkey River near Hanover	TN	0.1451	0.0017	15.6	Degrading
01673000	Pamunkey River near Hanover	DNO23	0.393	<0.0001	48.1	Degrading
01673000	Pamunkey River near Hanover	TP	0.7053	<0.0001	102.4	Degrading
01673000	Pamunkey River near Hanover	DIP	0.7139	<0.0001	104.2	Degrading
01673000	Pamunkey River near Hanover	TSS	0.4929	0.0004	63.7	Degrading
01674500	Mattaponi River near Beulahville	TN	-0.0589	0.1542	-5.7	No Trend
01674500	Mattaponi River near Beulahville	DNO23	0.0859	0.366	9	No Trend
01674500	Mattaponi River near Beulahville	TP	-0.1455	0.0263	-13.5	Improving
01674500	Mattaponi River near Beulahville	DIP	-0.3636	<0.0001	-30.5	Improving
01674500	Mattaponi River near Beulahville	TSS	-0.0485	0.6751	-4.7	No Trend
01668000	Rappahannock River near Fredericksburg	TN	-0.1609	0.0221	-14.9	Improving
01668000	Rappahannock River near Fredericksburg	DNO23	-0.2941	0.0281	-25.5	Improving
01668000	Rappahannock River near Fredericksburg	TP	-0.3366	0.0021	-28.6	Improving
01668000	Rappahannock River near Fredericksburg	DIP	-0.1914	0.0575	-17.4	No Trend
01668000	Rappahannock River near Fredericksburg	TSS	-0.3082	0.0679	-26.5	No Trend

Figures



1 Station 01668000 - Rappahannock River near Fredericksburg
2 Station 01674500 - Mattaponi River near Beulahville
3 Station 01673000 - Pamunkey River near Hanover
4 Station 02035000 - James River at Cartersville
5 Station 02041650 - Appomattox River
6 Station 02042500 - Chickahominy River

Figure 1. Locations of the USGS/DEQ River Input Monitoring stations in each of the Virginia tributaries.

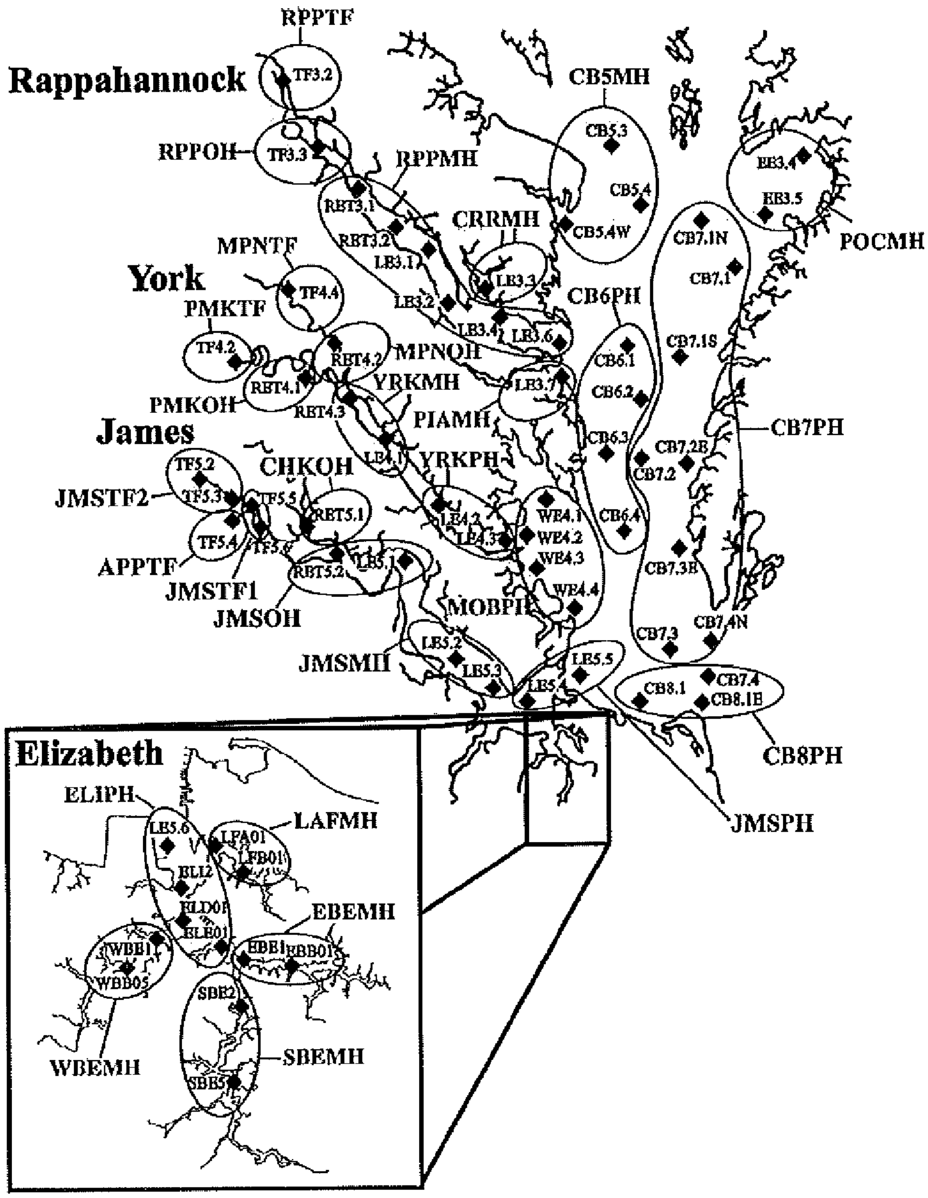


Figure 2. Map showing the locations of the water quality monitoring stations in the Virginia tributaries and the Lower Chesapeake Bay main stem used in the statistical analyses. Also shown are ellipses that delineate the Chesapeake Bay Program segmentation scheme.

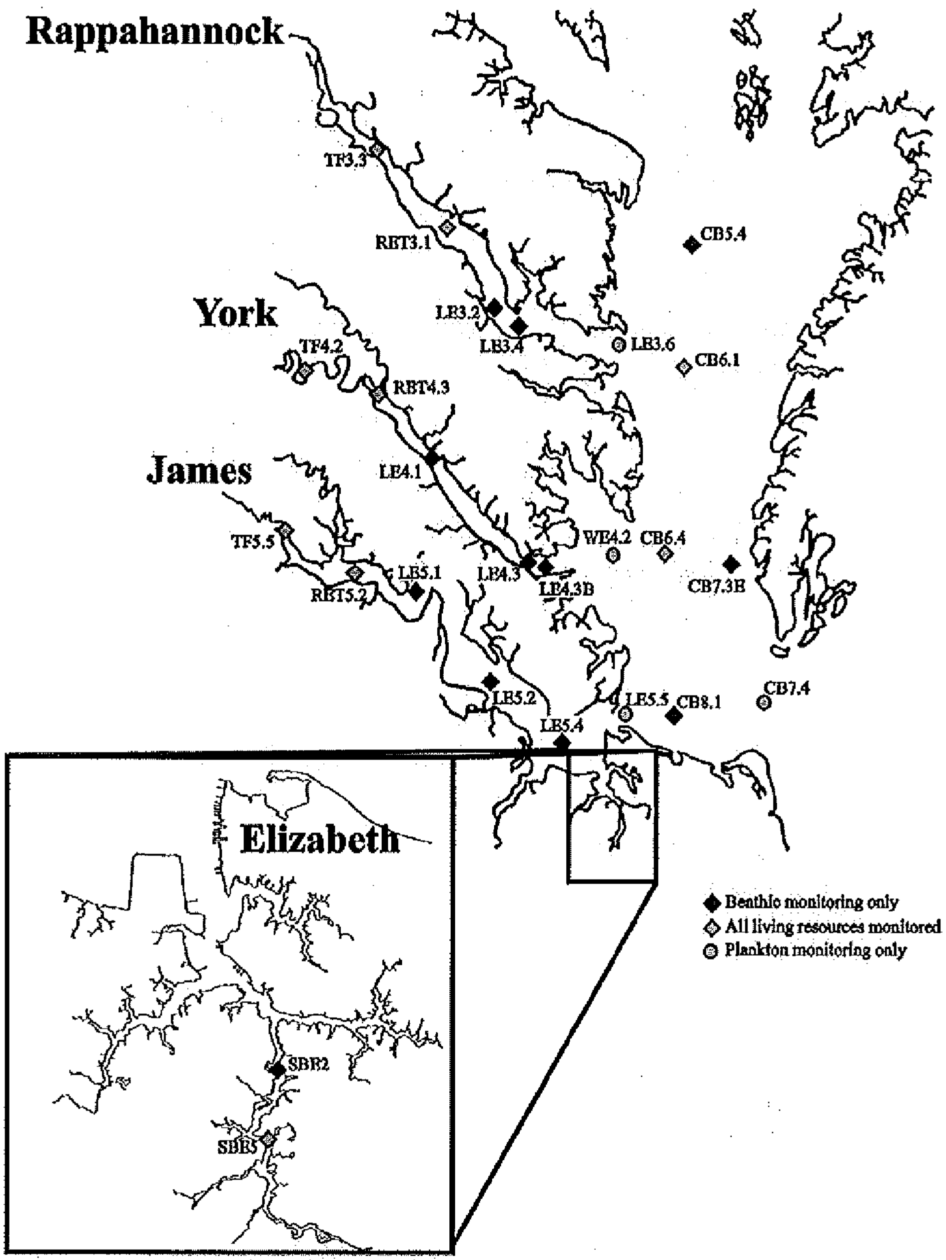
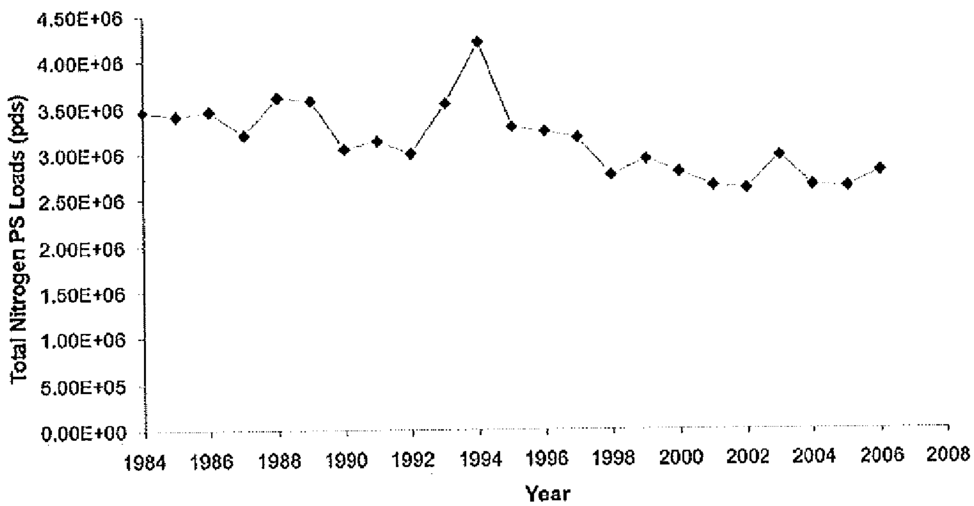


Figure 3. Location of living resource monitoring stations in the Virginia tributaries and the Lower Chesapeake Bay main stem.

A. James River Above the Fall-Line



B. James River Below the Fall-Line

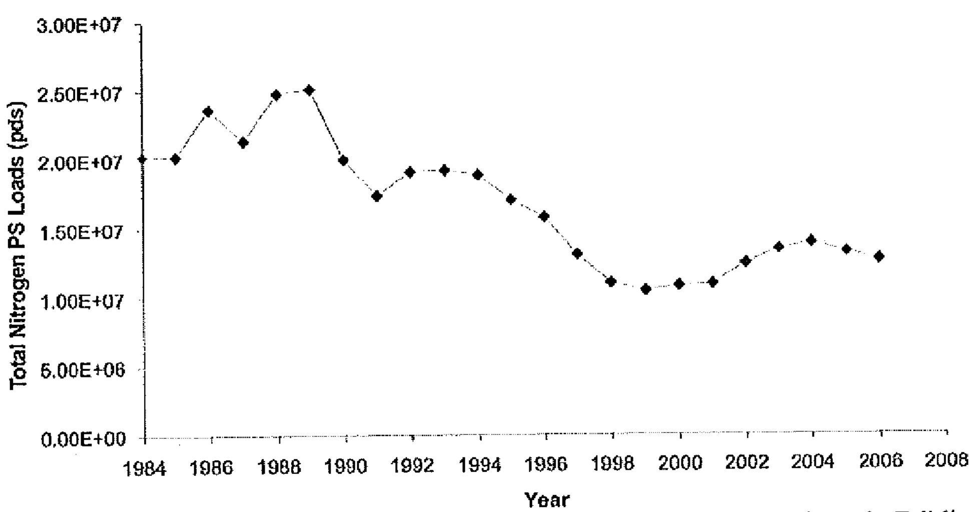
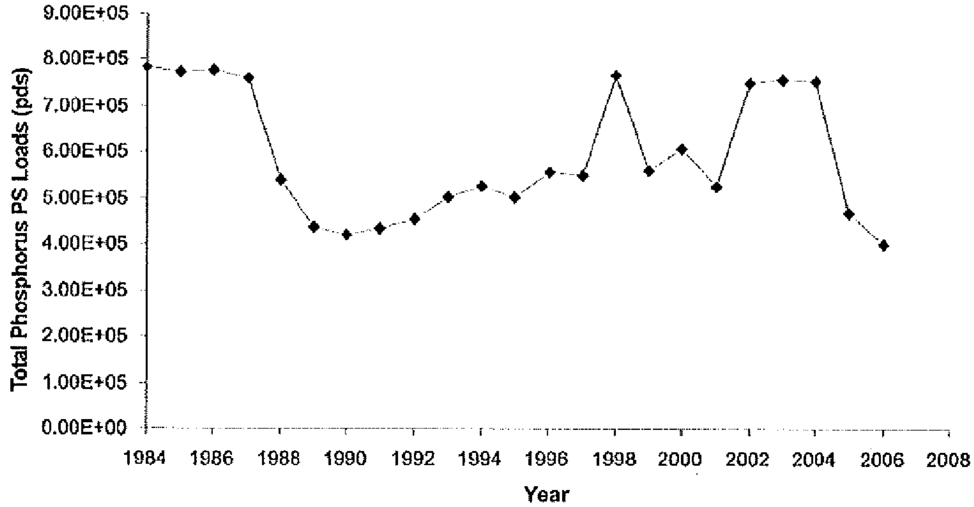


Figure 4. Long-term changes in point source total nitrogen loadings A. Above the Fall-line, and B. Below the Fall-line in the James River for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.

A. James River Above the Fall-Line



B. James River Below the Fall-Line

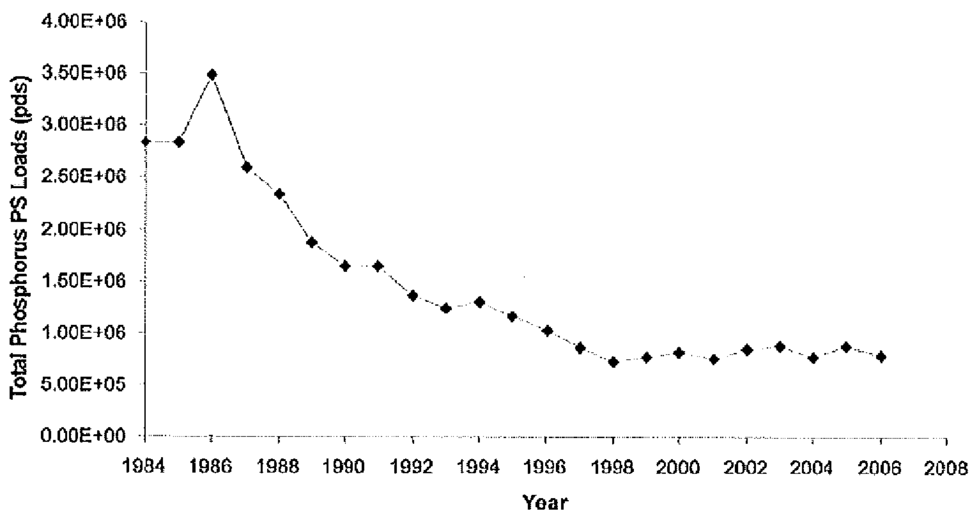
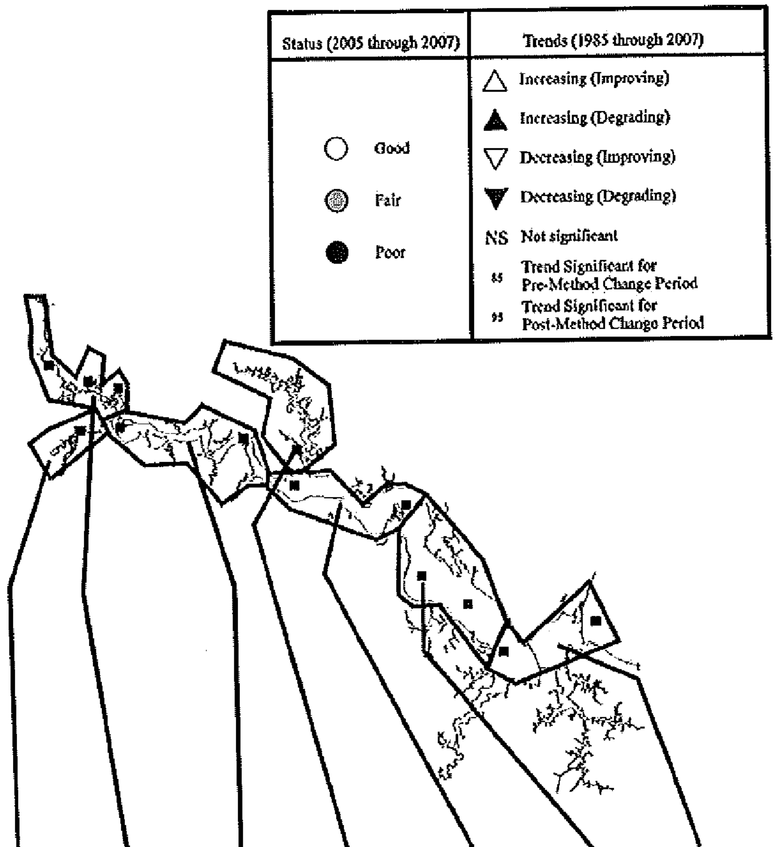
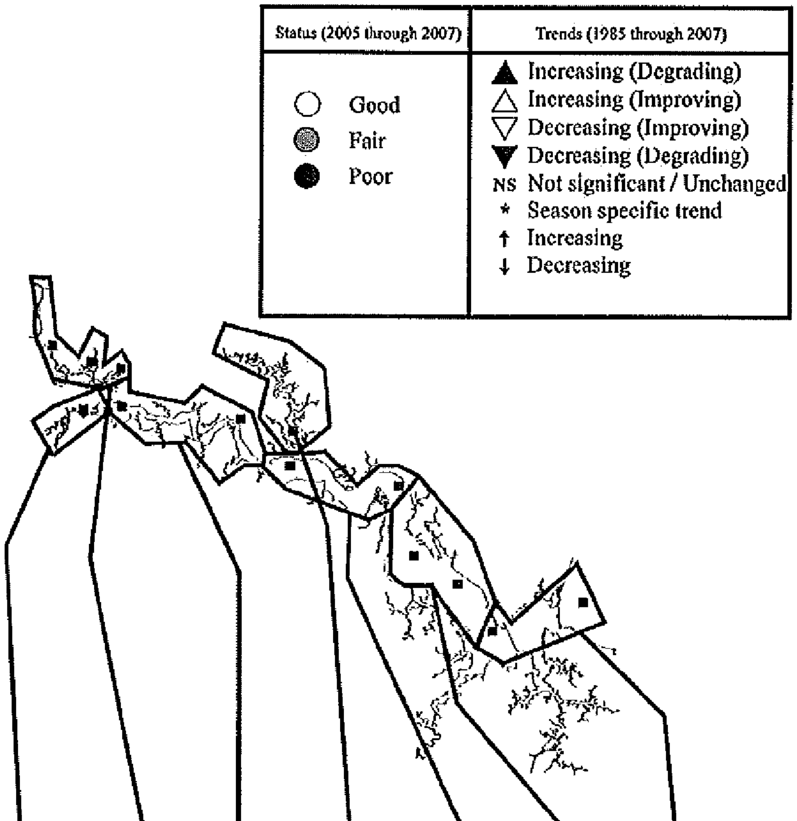


Figure 5. Long-term changes in point source total phosphorus loadings A. Above the Fall-line, and B. Below the Fall-line in the James River for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.



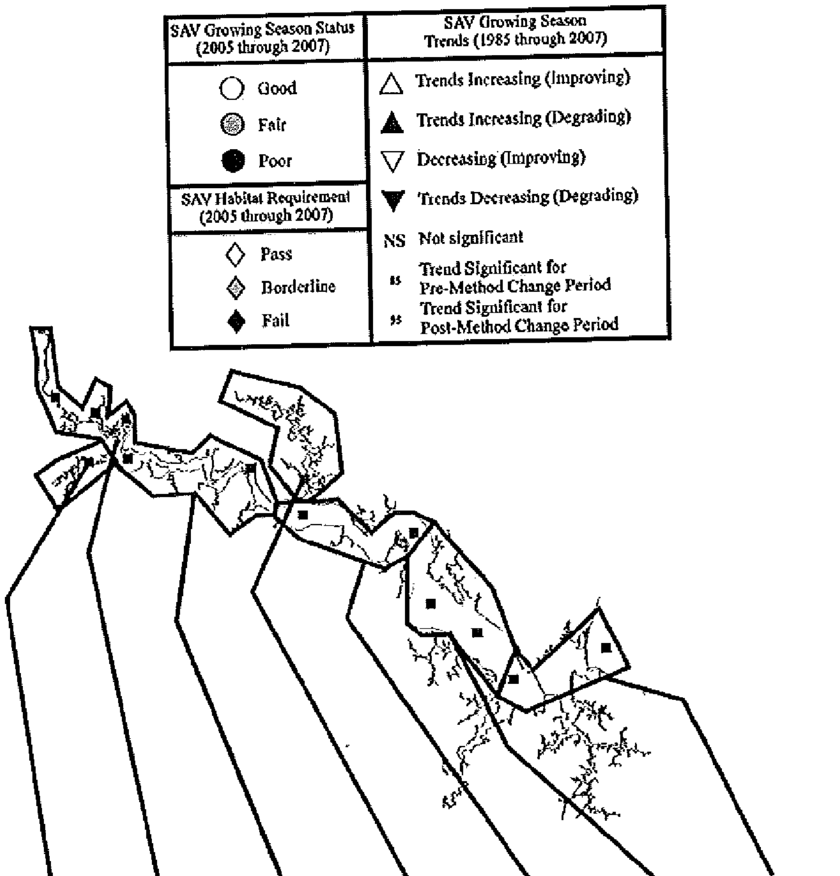
Parameter	Appomattox		Upper James 2		Upper James 1		Chickahominy		Middle James		Lower James		River Mouth	
STN	○	NS	○	▽85 ▲95	○	▽	○	▽	○	NS	○	NS	○	NS
BTN	○	NS	○	▽85 ▲95	○	▽95	○	▽	○	NS	○	NS	◎	NS
SDIN	○	NS	○	▽85	○	NS	○	NS	○	▽85	◎	NS	○	▲95
BDIN	○	NS	○	▽85	○	NS	○	NS	○	NS	◎	NS	○	NS
STP	○	NS	○	▽85	○	▽85	○	NS	◎	NS	◎	▲85	◎	NS
BTP	○	NS	○	▽85	○	▲85 ▽95	○	▽95	●	▲85	●	NS	◎	NS
SDIP	○	▽	○	▽	○	NS	○	▽	◎	NS	●	▲	◎	NS
BDIP	○	▽	◎	▽	◎	▽	○	▽	◎	NS	◎	▲	○	NS

Figure 6. Map of the James River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007. Abbreviations for each parameter are: TN=total nitrogen, DIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



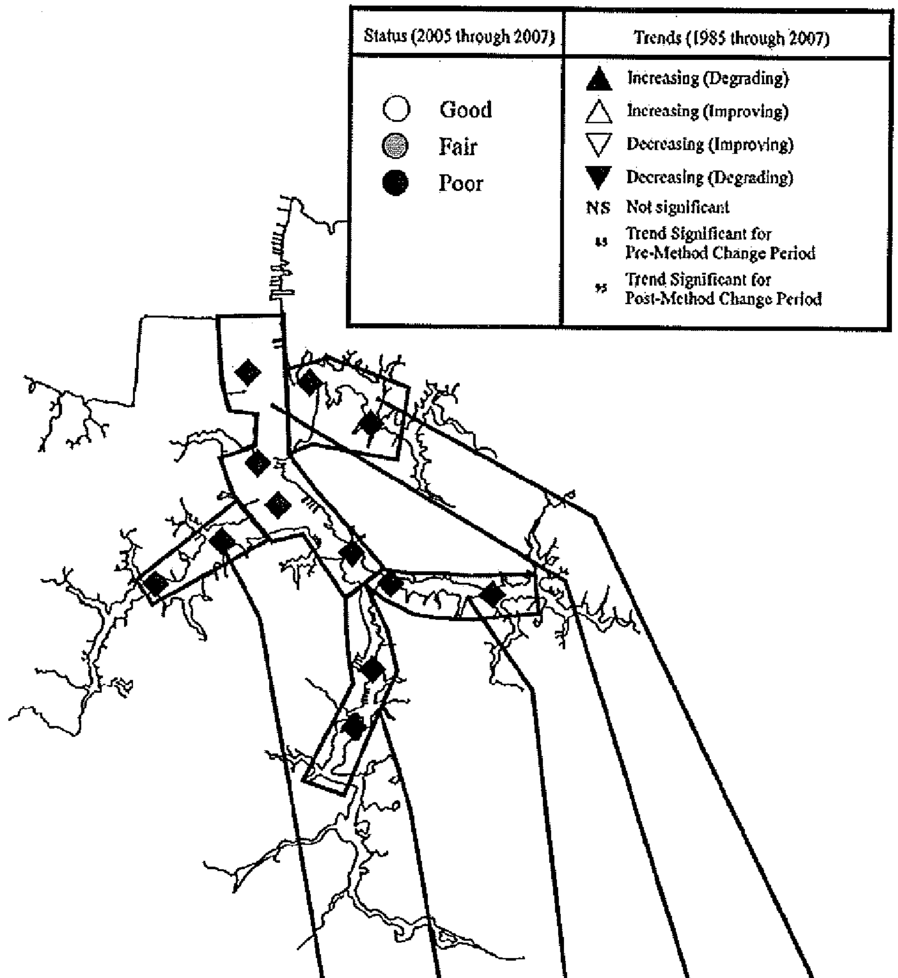
Parameter	Appomattox	Upper James 2	Upper James 1	Chickahominy	Middle James	Lower James	River Mouth
SCHLA	● NS	○ NS	○ ▽	◎ ▽	○ NS	○ NS	● ▲
STSS	● NS	◎ NS	◎ NS	● NS	● NS	● NS	◎ NS
BTSS	◎ NS	◎ ▲	◎ NS	● NS	● NS	● ▲	◎ NS
SECCHI	● NS	◎ ▼	◎ ▼	◎ ▼	● NS	● NS	● ▼
BDO	○ △	○ NS	○ NS	○ NS	○ NS	○ NS	○ △
SSALIN	NS	NS	NS	NS	NS	NS	↓
BSALIN	NS	NS	NS	NS	NS	NS	↓
SWTEMP	↑	NS	NS	NS	NS	NS	NS
BWTEMP	NS	NS	NS	NS	NS	NS	↑

Figure 7. Map of the James River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007. Abbreviations for each parameter are: CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=secchi depth, DO=dissolved oxygen, WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



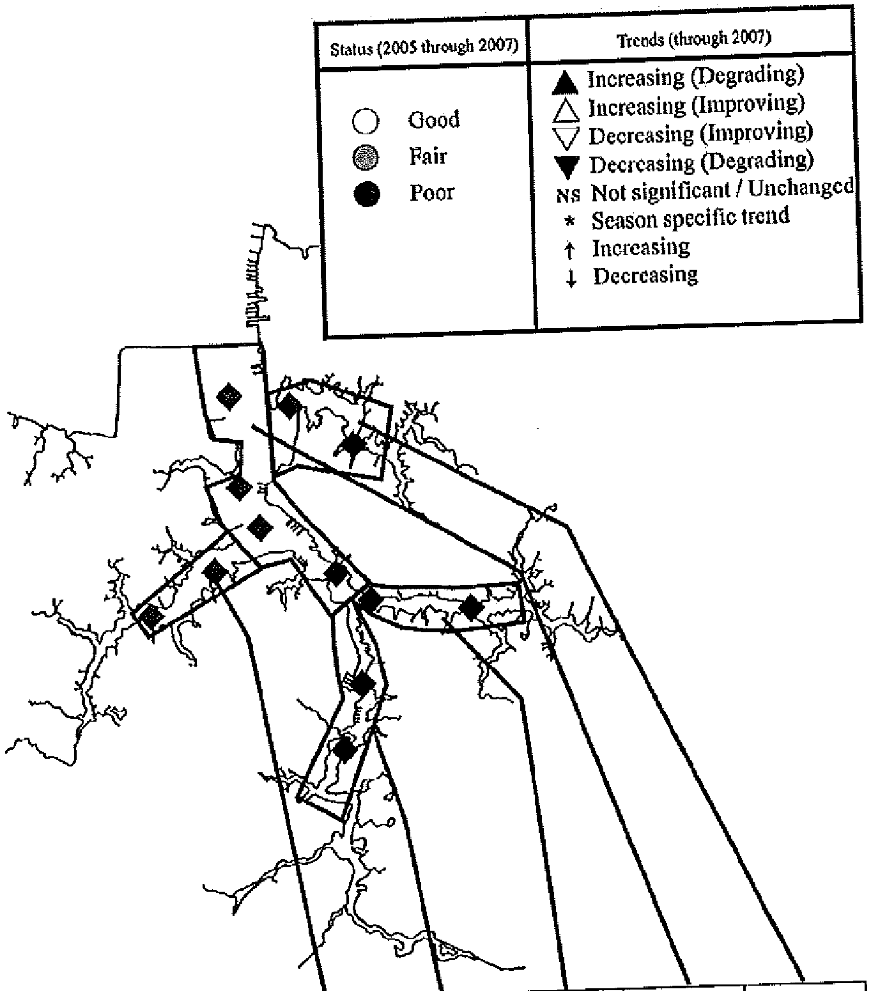
Parameter	Appomattox	Upper James 2	Upper James 1	Chickahominy	Middle James	Lower James	River Mouth
STN	○ NS	○ ▽ss ▲ss	○ ▽	○ NS	○ NS	○ NS	◍ NS
SDIN	○ NS	○ NS	○ ▽ss	○ ▲ss	○ ◇ ▽ss	◍ ◈ NS	◍ ◆ NS
STP	○ NS	○ ▽ss	○ NS	○ NS	○ NS	◍ ▲ss	● ▲ss
SDIP	○ ◇ ▽	○ ◈ ▽	○ ◈ NS	○ ◇ NS	◍ ◈ NS	● ◆ ▲	◍ ◈ NS
SCHLA	● ◈ NS	○ ◇ NS	○ ◇ ▽	◍ ◇ ▽	○ ◇ NS	○ ◇ NS	● ◇ NS
STSS	● ◆ NS	◍ ◈ NS	◍ ◈ NS	● ◆ NS	● ◆ NS	● ◈ NS	◍ ◇ NS
SECCHI	● ◆ ▼	● ◆ ▼	◍ ◈ ▼	◍ ◆ ▼	● ◆ NS	● ◆ NS	● ◈ ▼
BDO	○ NS	○ NS	○ NS	○ NS	○ NS	○ NS	○ △

Figure 8. Map of the James River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007 for the SAV growing season. Abbreviations for each parameter arc: TN=total nitrogen, SDIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus, CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=Secchi depth, DO=dissolved oxygen. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



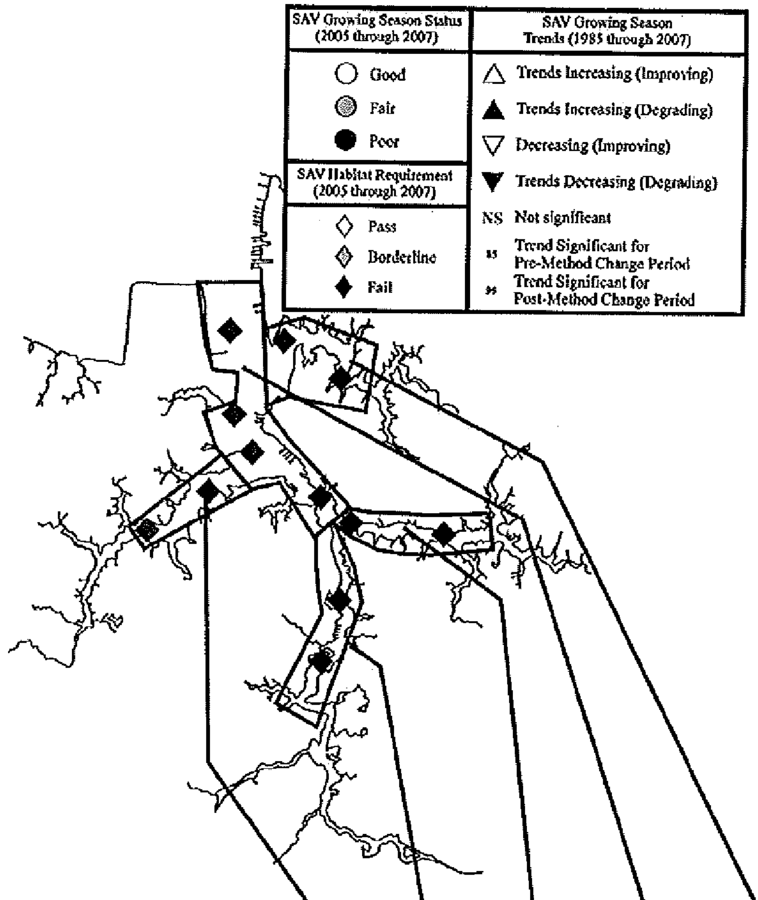
Parameter	Western Branch		Southern Branch		Eastern Branch		Elizabeth River Mainstem		Lafayette River	
STN	◉	NS	●	▽	◉	NS	◉	NS	◉	NS
BTN	◉	NS	●	NS	●	▽	●	▲	◉	NS
SDIN	◉	NS	●	▽	●	▽	●	NS	○	NS
BDIN	◉	NS	●	▽	●	▽	●	▽	○	NS
STP	●	NS	●	▽	●	▽	●	NS	●	NS
BTP	●	NS	◉	▽	◉	▽	●	NS	◉	NS
SDIP	●	NS	●	▽	●	NS	●	NS	◉	NS
BDIP	◉	NS	●	▽	●	▽	●	NS	◉	NS

Figure 9. Map of the Elizabeth River basin showing summaries of the status and trend analyses for each segment for the period of 1989 through 2007. Abbreviations for each parameter are: TN=total nitrogen, DIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP= dissolved inorganic phosphorus. The prefixes S and B refer to surface and bottom measurements, respectively.



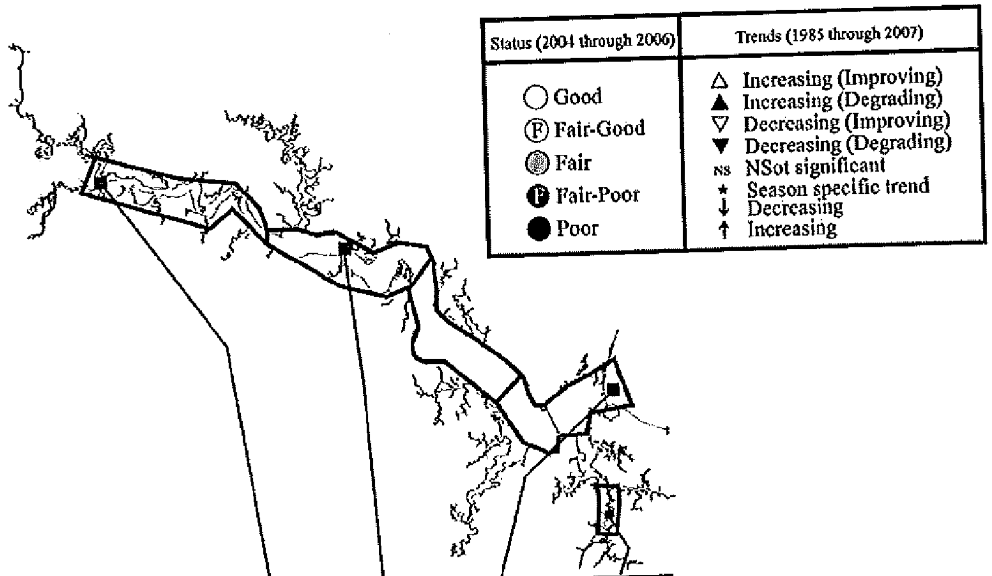
Parameter	Western Branch		Southern Branch		Eastern Branch		Elizabeth River Mainstem		Lafayette River	
SCHLA	●	NS	○	NS	◎	NS	◎	NS	●	NS
STSS	●	NS	◎	▽	◎	▽	◎	▽	●	NS
BTSS	●	NS	○	▽	○	▽	◎	▽	●	NS
SECCHI	●	NS	●	NS	●	NS	●	▼	●	NS
BDO	○	NS	◎	NS	◎	NS	○	NS	○	NS
SSALIN		NS		NS		NS		NS		NS
BSALIN		NS		NS		NS		↓		NS
SWTEMP		NS		↑		NS		↑		NS
BWTEMP		NS		↑		↑		NS		NS

Figure 10. Map of the Elizabeth River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007. Abbreviations for each parameter are: CHLA=chlorophyll a, TSS=total suspended solids, SECCHI=secchi depth, DO=dissolved oxygen, WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Western Branch	Southern Branch	Eastern Branch	Elizabeth River Mainstem	Lafayette River
STN	◍ NS	● ▽	◍ NS	● ▲	◍ NS
SDIN	◍ ◇ NS	● ◈ ▽	● ◆ ▽	● ◈ ▲	● ID NS
STP	● NS	● ▽	● NS	● NS	● NS
SDIP	● ◈ NS	● ◆ NS	● ◈ NS	● ◈ NS	● NS
SCHLA	◍ ◈ NS	○ ◇ NS	○ ◇ ▲	○ ◇ NS	◍ ID NS
STSS	● ◆ NS	○ ◇ ▽	◍ ◇ NS	● ◈ ▽	● ID NS
SECCHI	● ◆ NS	● ◈ NS	● ◈ NS	● ◆ ▼	● ID NS
BDO	○ NS	○ NS	○ NS	○ NS	○ NS

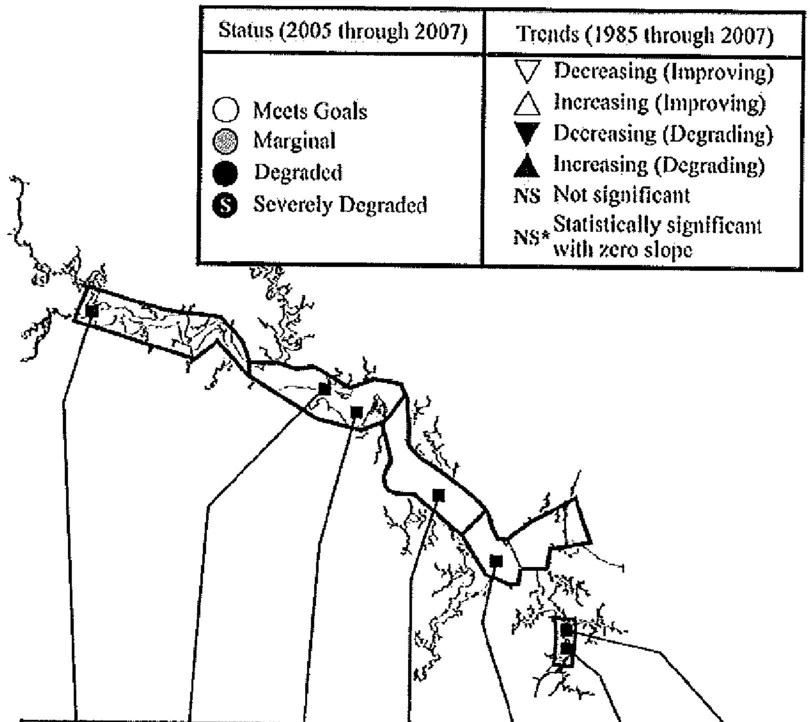
Figure 11. Map of the Elizabeth River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007 for the SAV growing season. Abbreviations for each parameter are: TN=total nitrogen, SDIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus, CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=Secchi depth, DO=dissolved oxygen. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



	TF5.5	RET5.2	LE5.5	SBE5
Phytoplankton IBI*	F NS	F NS	F NS	F ▼
Total Biomass	↑	↑	NS	NS
Biomass to Abundance	△	△	△	NS
Margalef Diversity Index	NS	▼	NS	NS
Productivity	▲	▽	NS	NS
Diatom Biomass	△	NS	NS	NS
Dinoflagellate Biomass	NS	NS	▲	NS
Cyanophyte Biomass	▲	NS	▲	▲
Chlorophyte Biomass	△	△	NS	NS
Picoplankton Biomass	▽	▽	NS	NS
Cryptophyte Biomass	NS	NS	NS	NS

* Status and trend results present for the Phytoplankton IBI were through 2006 due to data availability.

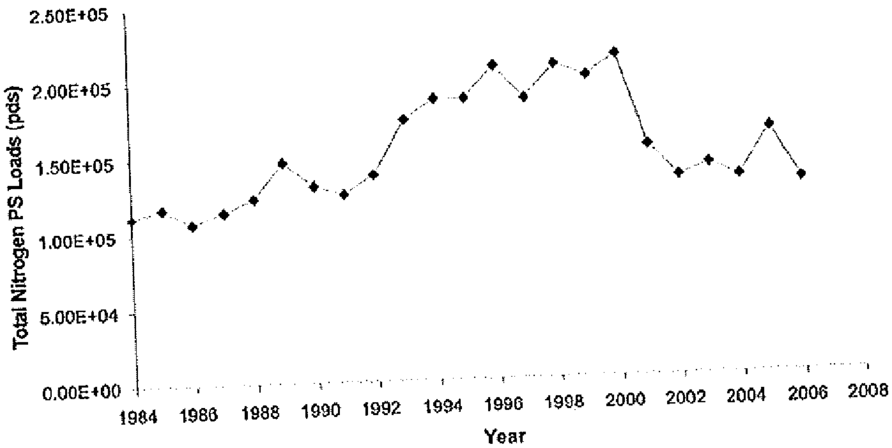
Figure 12. Map of the James River basin showing summaries of the status and trend analyses for the Phytoplankton Index of Biotic Integrity (P-IBI) and trend analyses of other phytoplankton bioindicators for each segment for the period of 1985 through 2007. Note that analytical results for the P-IBI are through 2006 due to data availability.



	TF5.5	RET5.2	LE5.1	LE5.2	LE5.4	SBE5	SBE2
Benthic IBI	● NS	◍ △	○ NS	◍ NS	○ NS	● △	● NS
Total Abundance	NS	NS	NS	△	NS	NS	△
Total Biomass	NS	NS	NS	NS	▼	NS	NS
Pollution Sensitive Species Abundance (%)	△	△	NS	△	NS	△	△
Pollution Indicative Species Abundance (%)	△	NS	NS	NS	▽	▽	▽
Pollution Sensitive Species Biomass (%)	△	△	NS	NS	▼	△	△
Pollution Indicative Species Biomass (%)	△	NS	NS	NS	NS	▽	NS
Shannon-Weiner Diversity Index	NS	△	NS	NS	▼	NS	NS

Figure 13. Map of the James River basin showing summaries of the status and trend analyses for Benthic Index of Biotic Integrity (B-IBI) and associated benthic bioindicators for each segment for the period of 1985 through 2007.

A. York River Above the Fall-Line



B. York River Below the Fall-Line

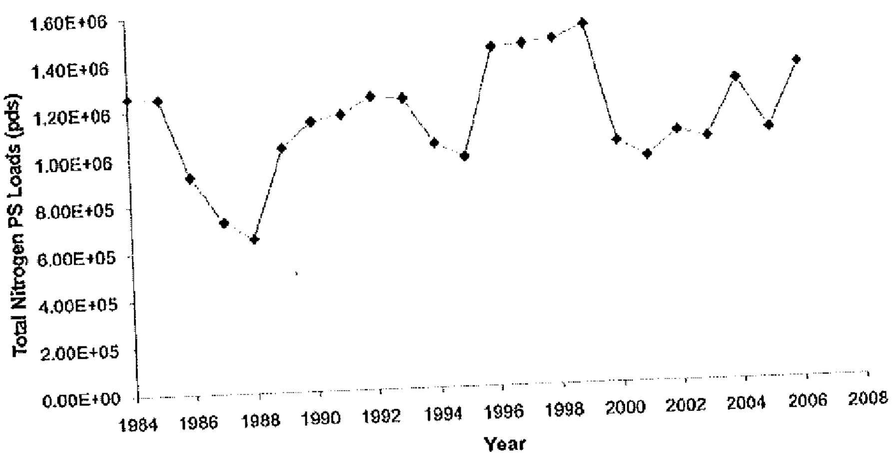
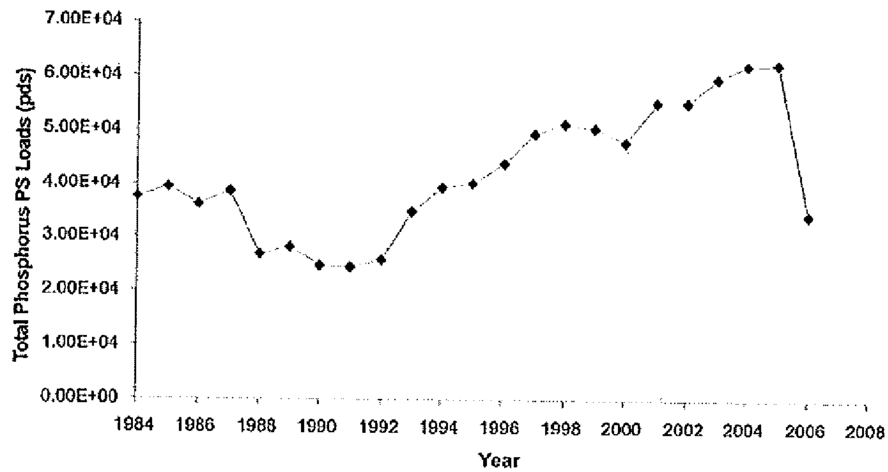


Figure 14. Long-term changes in point source total nitrogen loadings in the York River A)Above the Fall-Line and B) Below the Fall-line for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.

A. York River Above the Fall-Line



B. York River Below the Fall-Line

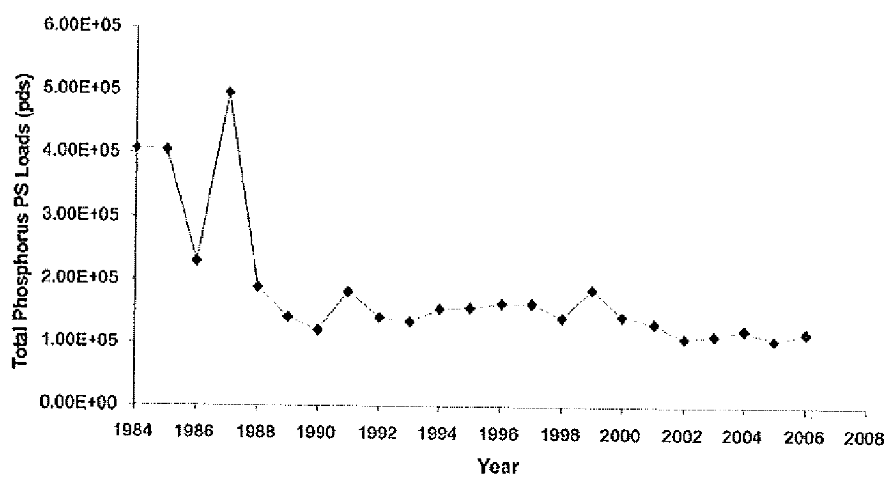


Figure 15. Long-term changes in point source total phosphorus loadings in the A) Above the Fall-Line B) Below the Fall-line for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.

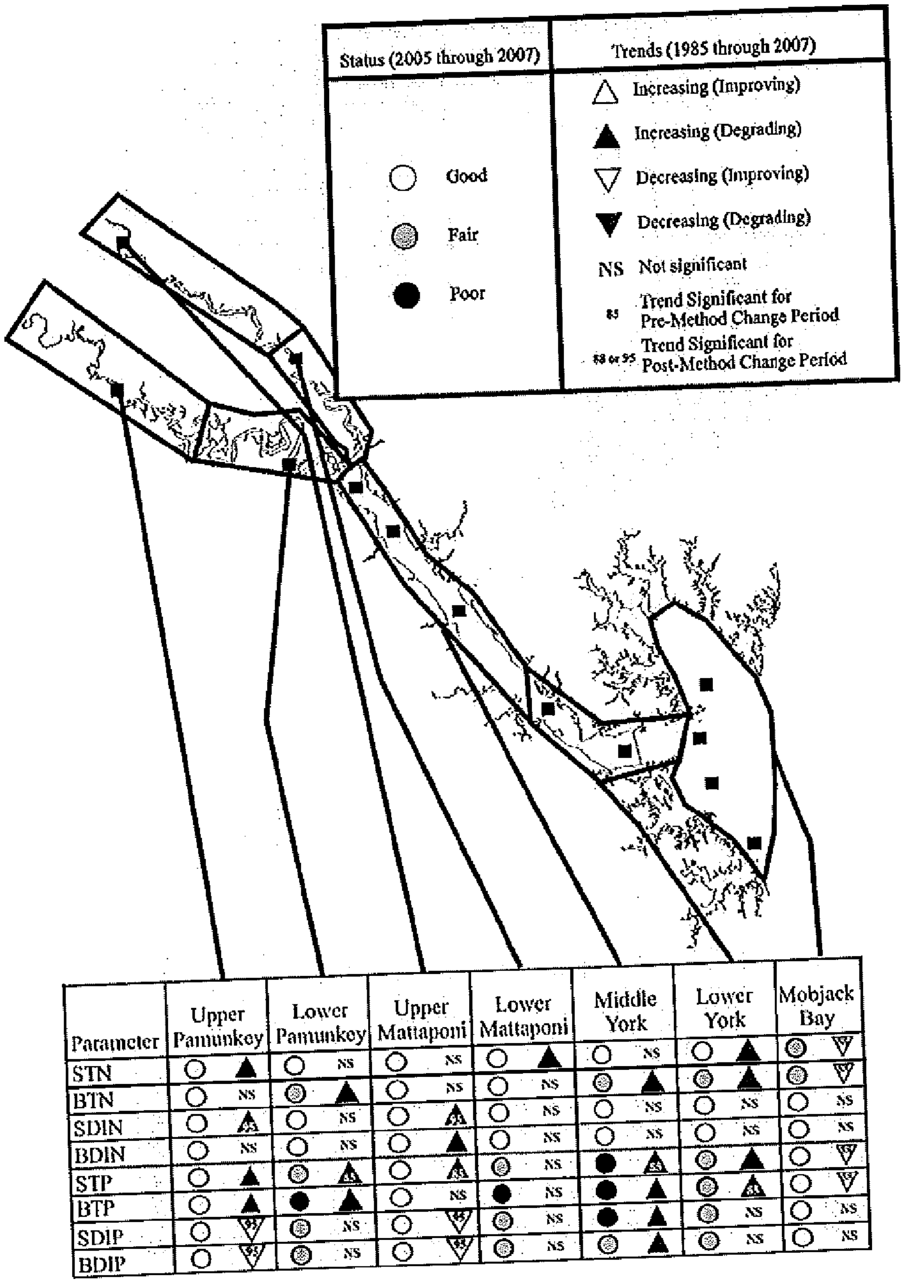
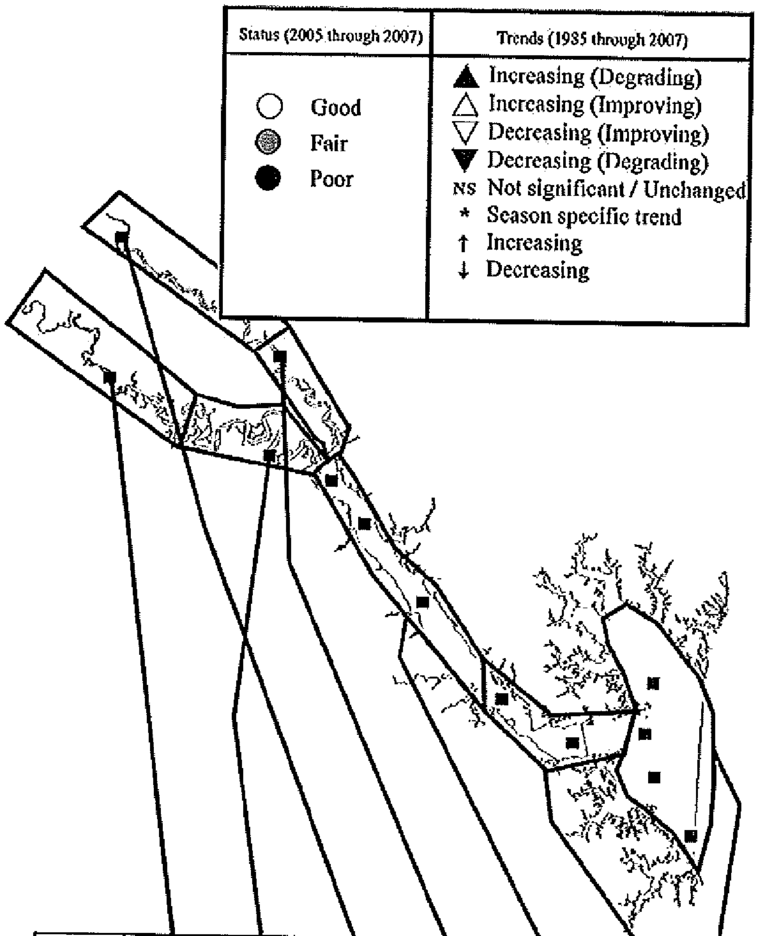
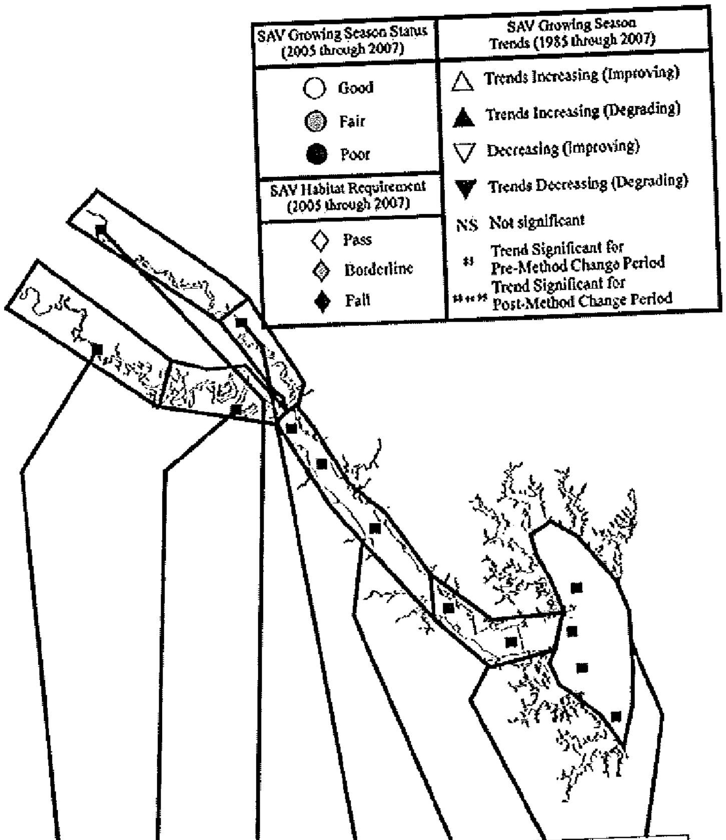


Figure 16. Map of the York River basin showing summaries of the status and trend analyses for each segment for the period of 1985 to 2007. Abbreviations for each parameter are: TN=total nitrogen, DIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



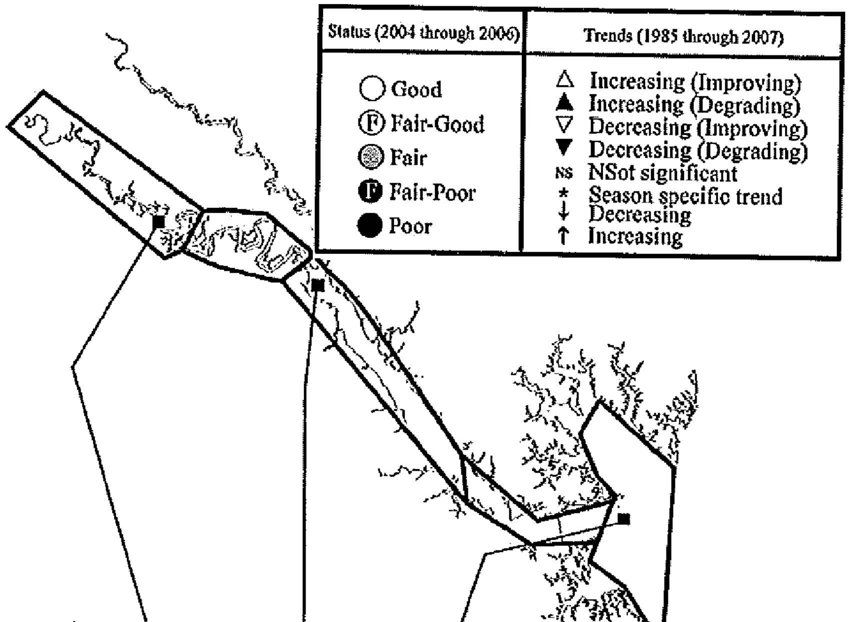
Parameter	Upper Pamunkey	Lower Pamunkey	Upper Mattaponi	Lower Mattaponi	Middle York	Lower York	Mobjack Bay
SCHLA	○ NS	○ NS	○ NS	○ NS	◉ NS	◉ ▲	◉ NS
STSS	◉ NS	● ▽	○ NS	● NS	● NS	◉ NS	◉ ▽
BTSS	○ NS	● NS	○ NS	● NS	● NS	● NS	● ▽
SECCHI	◉ ▼	● NS	○ ▼	● NS	● NS	● ▼	● ▼
BDO	○ △	◉ NS	○ NS	○ NS	◉ NS	◉ NS	○ △
SSALIN	NS	↑	NS	↑	NS	↓	↓
BSALIN	NS	NS	NS	↑	NS	NS	↓
SWTEMP	NS	NS	↑	NS	NS	NS	NS
BWTEMP	NS	NS	NS	NS	NS	NS	NS

Figure 17. Map of the York River basin showing summaries of the status and trend analyses for each segment for the period of 1985 to 2007. Abbreviations for each parameter are: CHLA=chlorophyll a, TSS=total suspended solids, SECCHI=secchi depth, DO=dissolved oxygen, WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Upper Pamunkey	Lower Pamunkey	Upper Mattaponi	Lower Mattaponi	Middle York	Lower York	Mobjack Bay
STN	○ NS	○ ▲	○ NS	○ ▲	○ NS	◎ ▲	◎ ▽
SDIN	○ NS	○ ◇ NS	○ NS	○ ◈ NS	○ ◇ NS	○ ◇ NS	○ ◇ NS
STP	○ NS	● ▽▲	○ NS	◎ ▲	● ▲	◎ ▲	◎ ▽
SDIP	○ ◇ ▽	◎ ◈ NS	○ ◇ ▽	◎ ◈ NS	● ◆ ▲	◎ ◇ NS	○ ◇ NS
SCHLA	○ ◇ NS	○ ◇ NS	○ ◇ NS	○ ◇ NS	○ ◇ NS	◎ ◇ NS	◎ ◇ NS
STSS	◎ ◈ NS	● ◆ ▽	○ ◇ NS	● ◆ NS	● ◆ NS	◎ ◇ NS	◎ ◇ ▽
SECCHI	◎ ◈ NS	● ◆ NS	○ ◇ NS	● ◆ NS	● ◆ NS	● ◈ ▼	● ◆ ▼
BDO	○ △	○ NS	○ NS	○ NS	○ NS	○ △	○ △

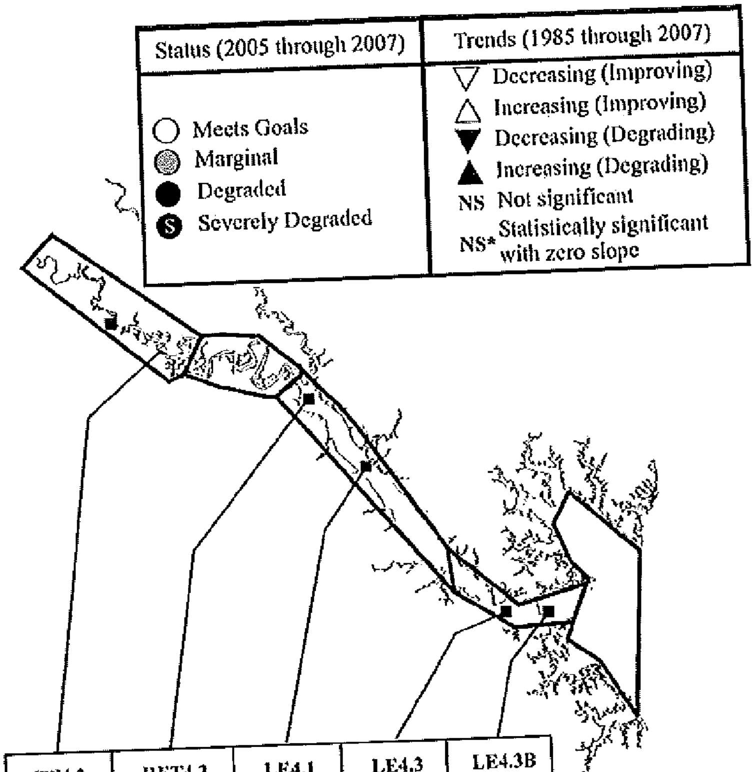
Figure 18. Map of the York River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007 for the SAV growing season. Abbreviations for each parameter are: TN=total nitrogen, SDIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus, CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=Secchi depth, DO=dissolved oxygen. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



	TF4.2	RET4.3	WE4.2
Phytoplankton IBI*	Fair NS	Poor NS	Fair NS
Total Biomass	NS	↑	NS
Biomass to Abundance	△	△	NS
Margalef Diversity Index	NS	NS	▼
Productivity	NS	▲	▲
Diatom Biomass	NS	NS	NS
Dinoflagellate Biomass	NS	NS	NS
Cyanophyte Biomass	▲	▲	▲
Chlorophyte Biomass	△	△	NS
Picoplankton Biomass	NS	NS	NS
Cryptophyte Biomass	NS	NS	↓

* Status and trend results present for the Phytoplankton IBI were through 2006 due to data availability.

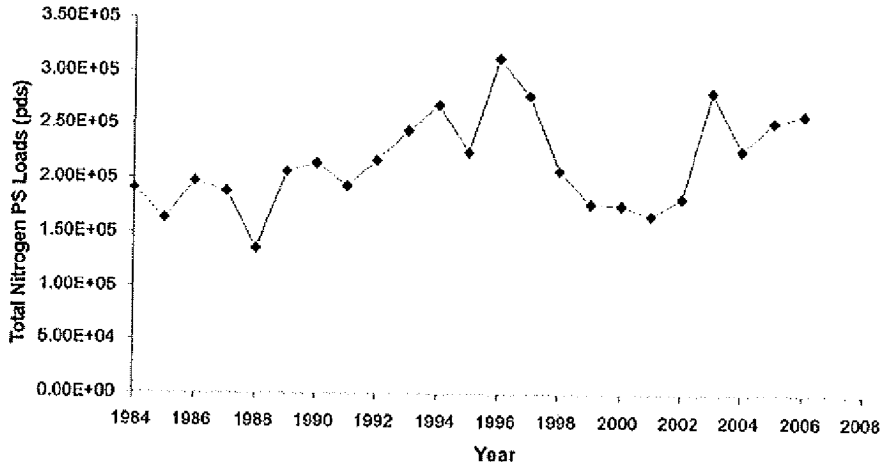
Figure 19. Map of the York River basin showing summaries of the status and trend analyses for the Phytoplankton Index of Biotic Integrity (P-IBI) and trend analyses of other phytoplankton bioindicators for each segment for the period of 1985 through 2007. Note that analytical results for the P-IBI are through 2006 due to data availability.



	TF4.2	RET4.3	LE4.1	LE4.3	LE4.3B
Benthic IBI	● NS	● NS	Ⓢ NS	○ NS	● △
Total Abundance	△	△	NS	NS	NS
Total Biomass	NS	NS	NS	NS	NS
Pollution Sensitive Species Abundance (%)	NS	NS	NS	NS	NS
Pollution Indicative Species Abundance (%)	NS	NS	NS	NS	▽
Pollution Sensitive Species Biomass (%)	NS	NS	▼	NS	NS
Pollution Indicative Species Biomass (%)	NS	NS	▲	NS	NS
Shannon-Weiner Diversity Index	△	NS	▼	NS	NS

Figure 20. Map of the York River basin showing summaries of the status and trend analyses for Benthic Index of Biotic Integrity (B-IBI) and associated benthic bioindicators for each segment for the period of 1985 through 2007.

A. Rappahannock River Above the Fall-Line



B. Rappahannock River Below the Fall-Line

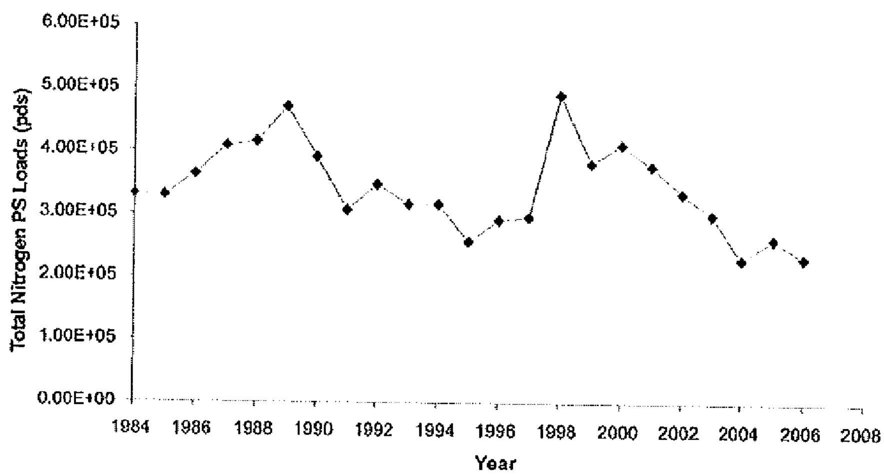
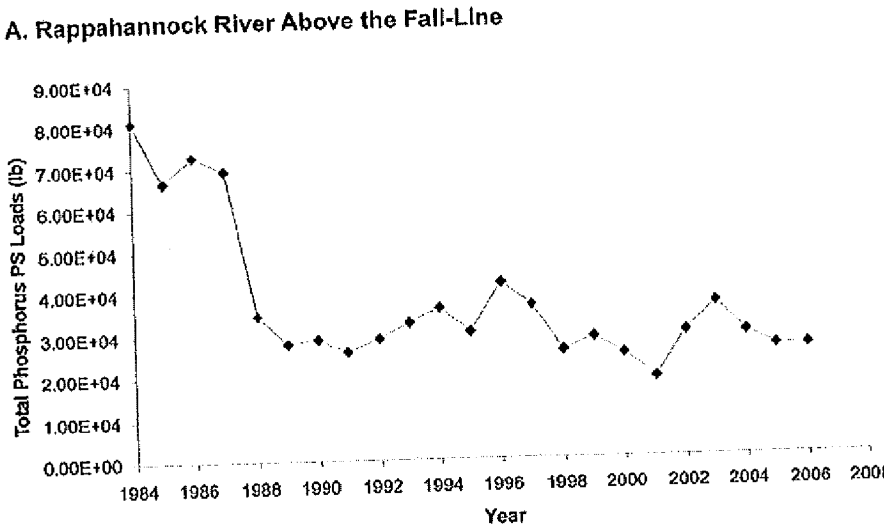


Figure 21. Long-term changes in point source total nitrogen loadings A. Above the Fall-line, and B. Below the Fall-line in the Rappahannock River for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.



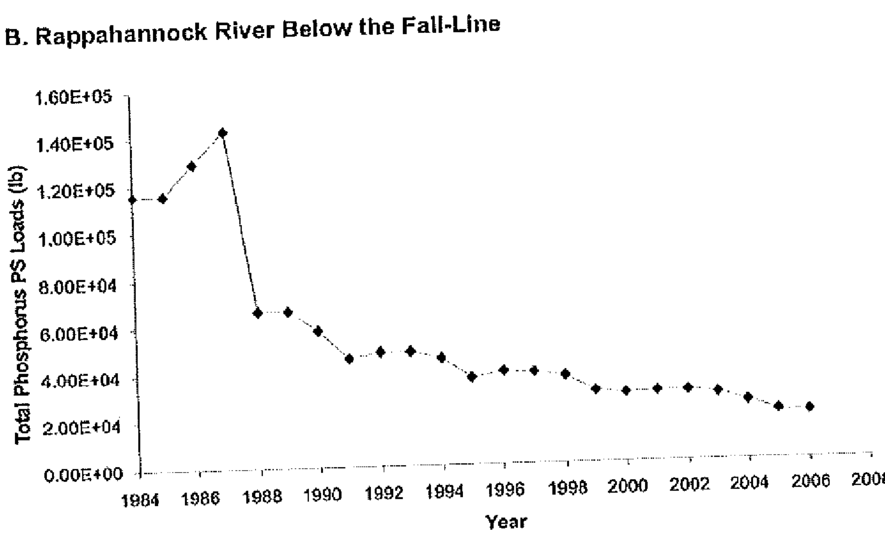
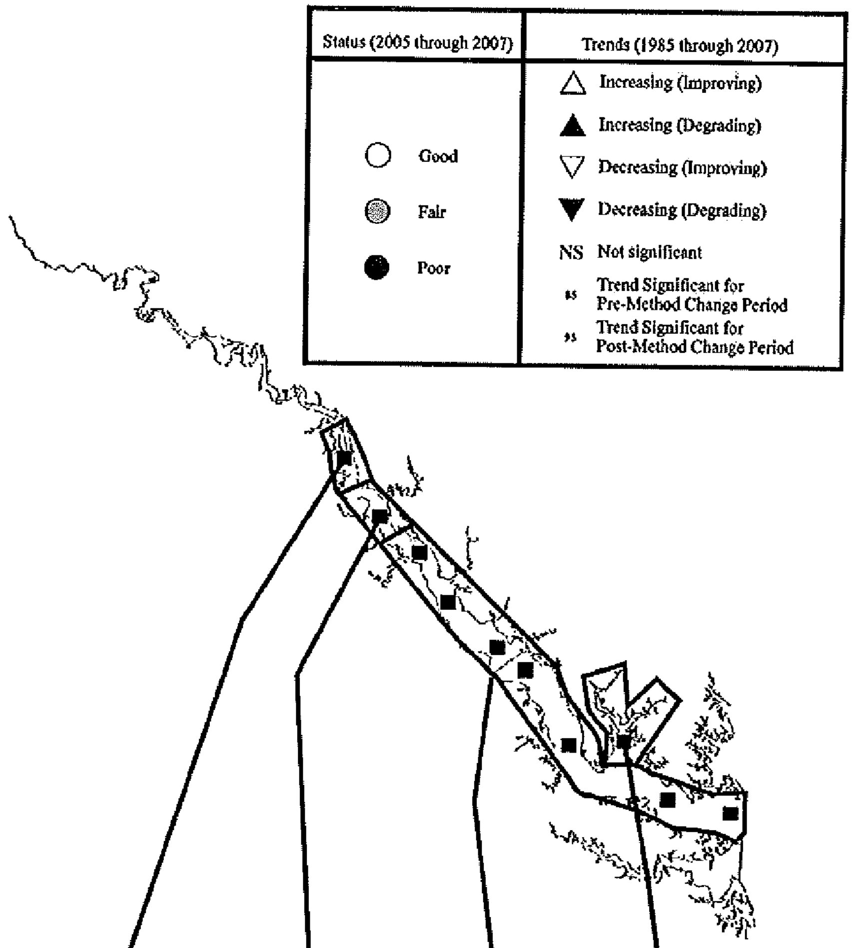
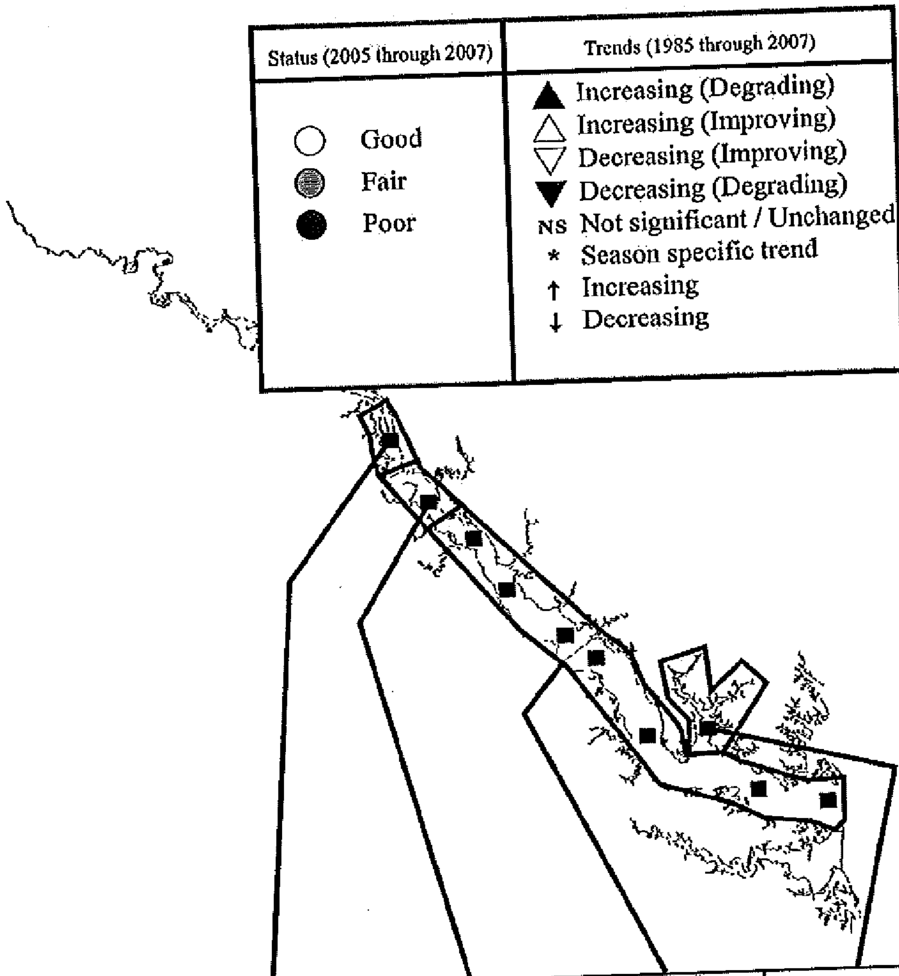


Figure 22. Long-term changes in point source total phosphorus loadings A. Above the Fall-line, and B. Below the Fall-line in the Rappahannock River for 1985 through 2006. Loadings presented are from data reported to the Virginia Department of Environmental Quality directly from point source dischargers.



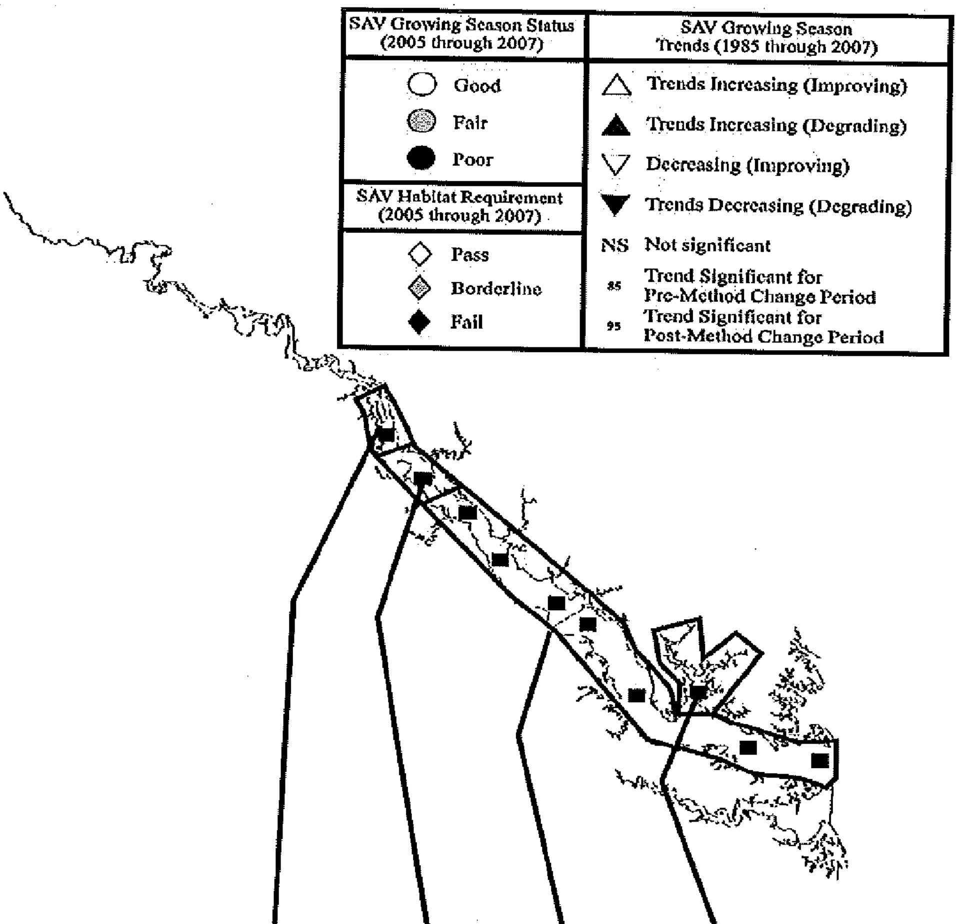
Parameter	Upper Rappahannock		Middle Rappahannock		Lower Rappahannock		Corottoman River	
STN	○	NS	○	NS	○	NS	○	NS
BTN	○	NS	○	▲	○	NS	○	NS
SDIN	○	NS	○	NS	○	▽ ss	○	▽
BDIN	○	NS	○	NS	○	NS	○	NS
STP	○	NS	◎	NS	○	▲ ss	○	▲
BTP	○	NS	◎	▲	○	▲ ss	○	▲ ss
SDIP	○	▽ ss	○	NS	○	NS	○	NS
BDIP	○	▽ ss	○	▽ ss	○	NS	○	NS

Figure 23. Map of the Rappahannock River basin showing summaries of the status and trend analyses for each segment for the period 1985 through 2007. Abbreviations for each parameter are: TN=total nitrogen, DIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.



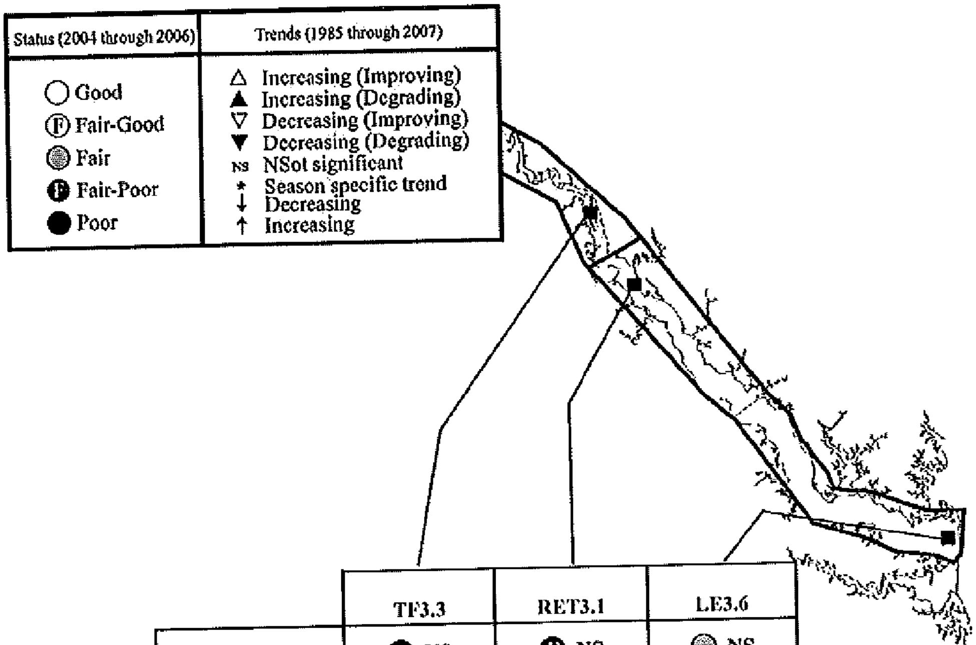
Parameter	Upper Rappahannock		Middle Rappahannock		Lower Rappahannock		Corottoman River	
SCHLA	○	NS	◍	▲	◍	▲	◍	NS
STSS	●	NS	●	NS	◍	NS	○	NS
BTSS	◍	NS	●	NS	◍	NS	○	NS
SECCHI	●	NS	●	NS	●	▼	◍	▼
BDO	○	NS	○	NS	◍	NS	◍	NS
SSALIN		NS		NS		↓		↓
BSALIN		NS		NS		↓		↓
SWTEMP		NS		NS		NS		NS
BWTEMP		NS		NS		NS		NS

Figure 24. Map of the Rappahannock River basin showing summaries of the status and trend analyses for each segment for the period 1985 through 2007. Abbreviations for each parameter are: CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=secchi depth, DO=dissolved oxygen, WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Upper Rappahannock	Middle Rappahannock	Lower Rappahannock	Corottoman River
STN	○ NS	○ NS	○ NS	○ NS
SDIN	○ NS	○ NS	○ ◇ ▽85	○ ◇ ▽
STP	○ NS	○ NS	◍ ▲85	◍ NS
SDIP	○ ◇ NS	○ ◇ NS	○ ◇ NS	◍ ◇ NS
SCHLA	○ ◈ NS	● ◈ ▲	◍ ◇ ▲	◍ ◇ NS
STSS	● ◆ NS	● ◆ NS	◍ ◇ NS	○ ◇ NS
SECCHI	● ◆ NS	● ◆ NS	● ◈ ▼	◍ ◇ ▼
BDO	○ NS	○ NS	○ NS	○ NS

Figure 25. Map of the Rappahannock River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007 for the SAV growing season. Abbreviations for each parameter are: TN=total nitrogen, SDIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus, CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=Secchi depth, DO=dissolved oxygen. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.

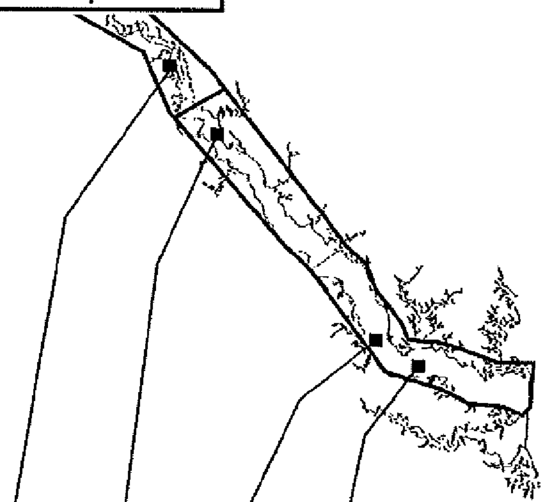


	TF3.3	RET3.1	LE3.6
Phytoplankton IBI*	● NS	🅕 NS	◍ NS
Total Biomass	↑	↑	NS
Biomass to Abundance	△	△	△
Margalef Diversity Index	NS	NS	▼
Productivity	▲	▲	▲
Diatom Biomass	△	△	NS
Dinoflagellate Biomass	▲	NS	▲
Cyanophyte Biomass	▲	▲	▲
Chlorophyte Biomass	△	△	NS
Picoplankton Biomass	NS	NS	▽
Cryptophyte Biomass	NS	NS	↓

* Status and trend results present for the Phytoplankton IBI were through 2006 due to data availability.

Figure 26. Map of the Rappahannock River basin showing summaries of the status and trend analyses for the Phytoplankton Index of Biotic Integrity (P-IBI) and trend analyses of other phytoplankton bioindicators for each segment for the period of 1985 through 2007. Note that analytical results for the P-IBI are through 2006 due to data availability.

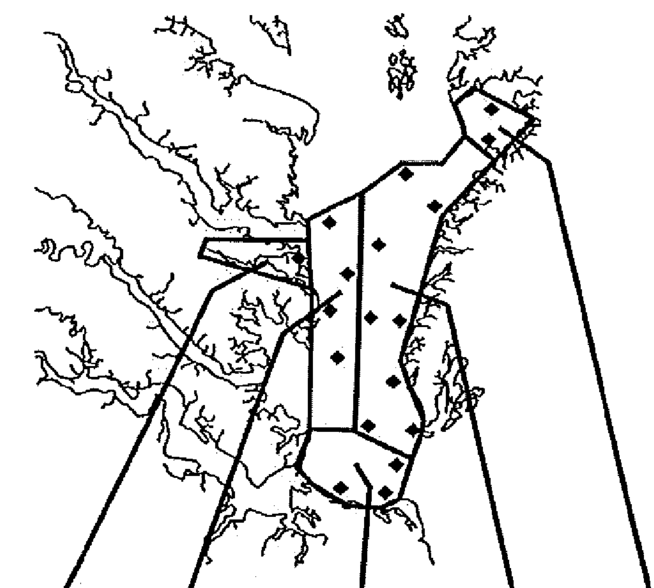
Status (2005 through 2007)	Trends (1985 through 2007)
○ Meets Goals ◍ Marginal ● Degraded Ⓢ Severely Degraded	▽ Decreasing (Improving) △ Increasing (Improving) ▼ Decreasing (Degrading) ▲ Increasing (Degrading) NS Not significant NS* Statistically significant with zero slope



	TF3.3	RET3.1	LE3.2	LE3.4
Benthic IBI	○ NS	◍ ▼	Ⓢ NS	Ⓢ NS
Total Abundance	NS	NS	NS	NS
Total Biomass	▼	▼	NS	NS
Pollution Sensitive Species Abundance (%)	NS	▼	NS	NS
Pollution Indicative Species Abundance (%)	NS	NS	NS	NS
Pollution Sensitive Species Biomass (%)	▼	▼	NS	NS
Pollution Indicative Species Biomass (%)	NS	NS	NS	NS
Shannon-Weiner Diversity Index	NS	NS	NS	NS

Figure 27. Map of the Rappahannock River basin showing summaries of the status and trend analyses for Benthic Index of Biotic Integrity (B-IBI) and associated benthic bioindicators for each segment for the period of 1985 through 2007.

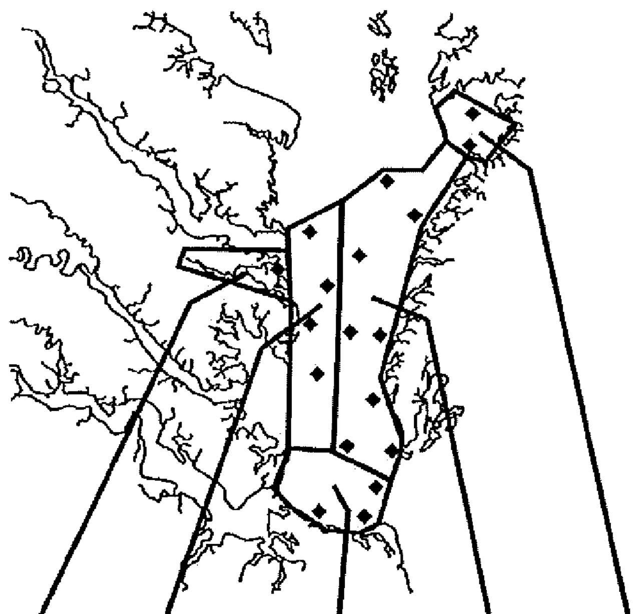
Status (2005 through 2007)	Trends (1985 through 2007)
○ Good ◍ Fair ● Poor	▲ Increasing (Degrading) △ Increasing (Improving) ▽ Decreasing (Improving) ▼ Decreasing (Degrading) NS Not significant ss Trend Significant for Pre-Method Change Period ss Trend Significant for Post-Method Change Period



Parameter	Piankatank River		Lower Western Mainstem		Lower Mainstem		Lower Eastern Mainstem		Pocomoke Sound	
STN	○	▽	○	▽	○	NS	○	▽	○	▽
BTN	○	▽	○	▽	○	NS	○	▽	◍	▽
SDIN	○	NS	○	NS	○	▲	○	NS	○	▽
BDIN	○	NS	◍	NS	○	▲▽	○	NS	○	▽
STP	○	▽	○	▽	○	▽	○	▽	○	▽
BTP	○	▽	○	NS	○	▽	○	▽	○	▽
SDIP	○	NS	○	NS	○	NS	○	NS	○	NS
BDIP	○	NS	○	NS	○	NS	○	NS	○	▽

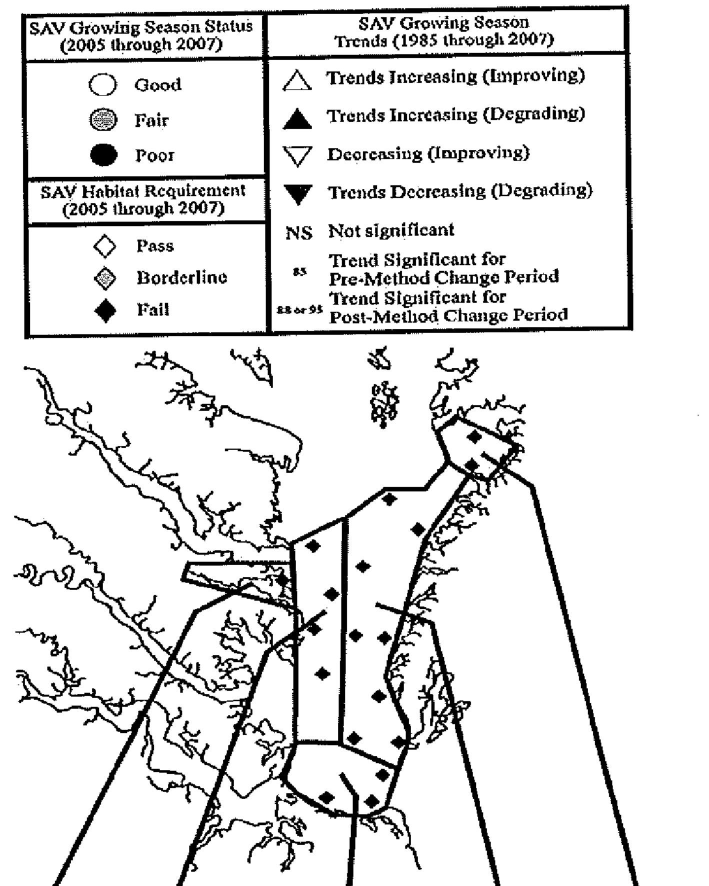
Figure 28. Map of the Virginia Chesapeake Bay Mainstem showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007. Abbreviations for each parameter are: TN=total nitrogen, DIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.

Status (2005 through 2007)	Trends (1985 through 2007)
○ Good ◉ Fair ● Poor	▲ Increasing (Degrading) △ Increasing (Improving) ▽ Decreasing (Improving) ▼ Decreasing (Degrading) NS Not significant / Unchanged * Season specific trend ↑ Increasing ↓ Decreasing



Parameter	Piankatank River	Lower Western Mainstem	Lower Mainstem	Lower Eastern Mainstem	Pocomoke Sound
SCHLA	◉ NS	◉ NS	○ NS	◉ NS	● NS
STSS	○ ▽	○ ▽	○ NS	○ ▲	● ▽
BTSS	○ ▽	○ ▽	○ NS	◉ ▲	◉ ▽
SECCHI	● ▼	◉ ▼	● ▼	◉ ▼	● ▼
BDISOXY	○ NS	◉ △	○ NS	○ NS	○ NS
SSALINITY	↓	↓	↓	↓	↓
BSALINITY	↓	↓	↓	↓	↓
SWTEMP	NS	NS	NS	NS	NS
BWTEMP	NS	NS	NS	NS	NS

Figure 29. Map of the James River basin showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007. Abbreviations for each parameter are: CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=secchi depth, DO=dissolved oxygen, WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.

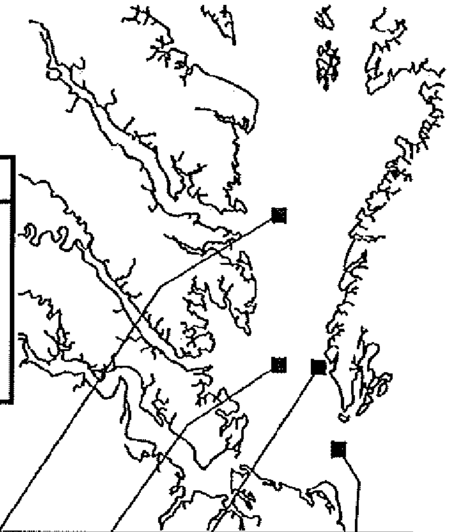


Parameter	Piankatank River	Lower Western Mainstem	Lower Mainstem	Lower Eastern Mainstem	Pocomoke Sound
STN	○ ▽(SS)	○ ▽(SS)	○ NS	○ ▽(SS)	◉ ▽(SS)
SDIN	○◇ NS	○◇ NS	○◇ ▲(SS)	○◇ NS	○◇ ▽(SS)
STP	○ NS	○ ▽(SS)	○ ▽	○ ▽(SS)	○ ▽(SS)
SDIP	○◇ NS	○◇ NS	○◇ NS	○◇ NS	○◇ NS
SCHLA	◉◇ NS	◉◇ NS	○◇ NS	◉◇ NS	●◇ NS
STSS	○◇ ▽	○◇ NS	○◇ NS	○◇ NS	●◈ NS
SECCHI	●◈ ▼	◉◇ ▼	●◇ ▼	◉◇ ▼	●◆ ▼
BDISOXY	○ △	○ △	○ △	○ △	○ NS

Figure 30. Map of the Virginia Chesapeake Bay Mainstem showing summaries of the status and trend analyses for each segment for the period of 1985 through 2007 for the SAV growing season. Abbreviations for each parameter are: TN=total nitrogen, SDIN=dissolved inorganic nitrogen, TP=total phosphorus, DIP=dissolved inorganic phosphorus, CHLA=chlorophyll *a*, TSS=total suspended solids, SECCHI=Secchi depth, DO=dissolved oxygen. The prefixes S and B refer to surfaceand bottom measurements, respectively. The presence of two trend symbols indicates a significant difference between pre- and post-method change trends. For such cases, the first symbol represents the pre-method change result while the second symbol is the post method change result.

AR0034732

Status (2004 through 2006)	Trends (1985 through 2007)
○ Good Ⓕ Fair-Good ◍ Fair 🅕 Fair-Poor ● Poor	△ Increasing (Improving) ▲ Increasing (Degrading) ▽ Decreasing (Improving) ▼ Decreasing (Degrading) NS NSot significant * Season specific trend ↓ Decreasing ↑ Increasing

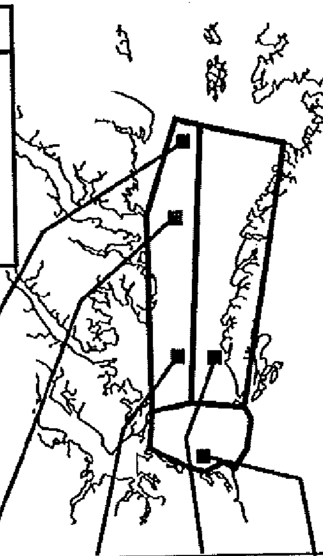


	CB6.1	CB6.4	CB7.3E	CB7.4
Phytoplankton IBI*	◍ NS	◍ NS	◍ NS	Ⓕ NS
Total Biomass	NS	NS	NS	↑
Biomass to Abundance	NS	△	△	△
Margalef Diversity Index	NS	▼	NS	▼
Productivity	NS	▲	NS	▲
Diatom Biomass	NS	NS	NS	△
Dinoflagellate Biomass	NS	▲	NS	▲
Cyanophyte Biomass	▲	▲	▲	▲
Chlorophyte Biomass	NS	NS	NS	NS
Picoplankton Biomass	▽	▽	NS	NS
Cryptophyte Biomass	↓	NS	NS	NS

* Status and trend results present for the Phytoplankton IBI were through 2006 due to data availability.

Figure 31. Map of the Virginia Chesapeake Bay Mainstem showing summaries of the status and trend analyses for the Phytoplankton Index of Biotic Integrity (P-IBI) and trend analyses of other phytoplankton bioindicators for each segment for the period of 1985 through 2007. Note that analytical results for the P-IBI are through 2006 due to data availability.

Status (2005 through 2007)	Trends (1985 through 2007)
○ Meets Goals ◍ Marginal ● Degraded Ⓢ Severely Degraded	▽ Decreasing (Improving) △ Increasing (Improving) ▼ Decreasing (Degrading) ▲ Increasing (Degrading) NS Not significant NS* Statistically significant with zero slope



	CB5.4	CB6.1	CB6.4	CB7.3E	CB8.1
Benthic IBI	Ⓢ NS	◍ NS	○ NS	○ NS	○ NS
Total Abundance	NS	△	△	NS	NS
Total Biomass	NS	NS	▼	NS	NS
Pollution Sensitive Species Abundance (%)	NS	NS	NS	NS	NS
Pollution Indicative Species Abundance (%)	NS	▲	NS	NS	▽
Pollution Sensitive Species Biomass (%)	NS	NS	NS	NS	▼
Pollution Indicative Species Biomass (%)	NS	▲	NS	NS	NS
Shannon-Weiner Diversity Index	NS	NS	△	NS	NS

Figure 32. Map of the Virginia Chesapeake Bay Mainstem showing summaries of the status and trend analyses for Benthic Index of Biotic Integrity (B-IBI) and associated benthic bioindicators for each segment for the period of 1985 through 2007.

ATTACHMENT P

TO: David K. Paylor

FROM: Alan E. Pollock

DATE: July 20, 2010

COPIES: Ellen Gilinsky

SUBJECT: **CONCERNS WITH JULY 1 DRAFT NUTRIENT ALLOCATIONS FOR THE JAMES RIVER BASIN BASED ON CHLOROPHYLL CRITERIA**

EXECUTIVE SUMMARY

- Proper assessment of model output must recognize the significant spatial and temporal variability of chlorophyll levels, in contrast to the more predictable dissolved oxygen patterns.

- EPA recognized this variability during the cooperative development process for the chlorophyll criteria in 2005, and included significant modeling evaluation of alternatives to address this issue. EPA approved the Virginia criteria based upon model assessment rules appropriate for chlorophyll attainment, in contrast to the rules that were used to develop the July 1 James River draft allocations.

- Recent information from the lower tidal James River 2010 Water Quality Assessment shows attainment, or at most 1% non-attainment, for those river segments. The expected reductions needed to meet the "dissolved oxygen-based" James River allocation [TN = 26.79 MPY; TP = 2.69 MPY] should achieve the criteria in this portion of the river without the additional reductions proposed by EPA.

- The additional reductions identified in the July 1 letter, which we do not believe are justified at this time, would increase costs to the citizens of the Commonwealth upwards of $500 million.

- Based on model results received from EPA in the past few days, absent the imposition of the chlorophyll issue in the James, the Virginia Tributary Strategy level of reductions would meet the draft nutrient allocations assigned to the Commonwealth.

CONCERNS WITH JULY 1 DRAFT NUTRIENT ALLOCATIONS FOR JAMES RIVER BASIN

I. <u>Methodology used to Develop Draft Allocations to Meet Chlorophyll Criteria is Not Appropriate</u>

- Chlorophyll model calibration is difficult due to its high natural variability. Caution must be taken in evaluating model results as the basis for assessing attainment and setting nutrient allocations for compliance with chlorophyll criteria.

- Concern that changes in chlorophyll (on the order of 1-2 ug/l seasonal average and 2-4% in terms of non-attainment rates) are smaller than those than can be precisely distinguished by the model, detected in monitoring data, or concluded to have ecological significance.

- The rules and procedures to assess model output need to be carefully examined to see what is appropriate for the chlorophyll parameter in contrast to what is appropriate for dissolved oxygen. Refer to **Attachment A** which summarizes the differences between these two parameters regarding precision of analytical methods, confidence of impairment, environmental variability, etc. For the Bay TMDL, EPA is using a "1% non-attainment rule" when evaluating model scenario output for judging dissolved oxygen attainment. We have not yet seen EPA's documentation to justify using the "1% non-attainment rule" for interpreting model results for dissolved oxygen. However, we continue to be concerned that using the "1% non-attainment rule" for modeling attainment for chlorophyll, given the significant differences in these parameters, is not technically justified.

  As discussed in more detail below under section II, when the chlorophyll standards were adopted in 2005, EPA endorsed using model assessment rules different from the rules used to establish the July 1 draft allocations. Model predictions allowed up to a 4% non-attainment rule for assessing attainability with the proposed standards for several of the criteria.

- **Attachment B** presents the results of the 2008 and 2010 Water Quality Assessments for the chlorophyll criteria in the tidal James River. The following conclusions are drawn by using the results of the 2010 Assessment [data from 2006-08] and the assessment procedures developed by EPA (2010) and being adopted into the Virginia Water Quality Standards, i.e., the far right column, **2010 IR Geo Mean Status**.

  1. The three lower James River segments for both spring and summer either attain standards, or are within 1% non-attainment. The most recent model results as analyzed by EPA show non-attainment in at least one season in these three segments for several 3-year cycles under the allocations based on meeting the dissolved oxygen criteria [TN = 26.79 MPY; TP = 2.69 MPY].

     Based on recent emails from EPA staff, we understand that in developing the proper allocations to address the chlorophyll criteria in the DC Potomac and Anacostia Rivers, EPA used additional lines of evidence, not just model output and data from the 1990s. One email stated: "For the [P]otomac, the current *monitoring* data showed the [P]otomac is in attainment for Chl[orophyll] and the [A]nacostia is only 4% non-attainment. That information combined with the fact that the [P]otomac allocation still requires additional load reductions beyond current loads made us conclude that these segments will attain for chl[orophyll] at the allocated load." It appears to us that a consistent line of evidence approach should be used for the lower James River segments where most recent data shows that they are currently either in attainment or at 1% non-attainment.

2. The 2010 Assessment shows non-attainment in both the James upper and lower Tidal Fresh segments for both seasons, especially for the summer season. However, for the upper Tidal Fresh segment, the model is showing attainment in both seasons for all of the 3-year cycles. For the lower Tidal Fresh in the spring, the model shows slight 2% non-attainment. For the lower Tidal Fresh in the summer, the model shows persistent non-attainment in half of the 3-year cycle periods.

   Given this situation, we have little confidence in using the model to assess attainment in these tidal fresh segments. The main conclusion we draw is that the monitoring data are still pointing us towards the real chlorophyll problem in the James, which is the tidal fresh sections, particularly the lower tidal fresh in the summer. As discussed in section II, Virginia needs to review the summer tidal fresh criteria, particularly the application of the Harmful Algal Bloom criteria published by EPA. We believe if EPA used the same model assessment rules for the 2010 TMDL that were used in the standards adoption process in 2005, Virginia would have the opportunity to conduct the necessary review and update of the chlorophyll criteria without unjustified allocations in the 2010 TMDL.

- For chlorophyll, EPA is assessing model results by requiring attainment throughout the entire 10-year modeling assessment period, i.e., the criteria must be met in all eight 3-year cycles. However, EPA worked though a consensus process that identified one 3-year cycle that accounts for critical conditions in setting allocations for dissolved oxygen criteria. They are also doing the same for SAV/clarity criteria.

  We continue to be concerned that the critical condition approach used for the chlorophyll criteria is overly conservative by requiring compliance in every assessment cycle over the entire model simulation period, especially compared to the other two water quality criteria in the Bay. In addition, as noted in section II below, when Virginia adopted the chlorophyll standards in 2005, EPA endorsed using model assessment of attainability for both a ten year average, as well as looking at the rolling 3-year averages.

- We are concerned over the lack of examination of the same problems that cause counterintuitive model results in some segment-seasons might also be causing more systematic, less obvious problems in other segment-seasons. We believe there is a need to develop a set of objective criteria for evaluating model behavior that includes: (1) a systematic evaluation of the ability of the model to quantify changes in chlorophyll; and (2) an evaluation of the causes of problematic model chlorophyll predictions, and how those causes might affect the model accuracy/precision in all of the James River segments for both spring and summer seasons.

- It is doubtful that Virginia would have taken the step of being the first to adopt numeric chlorophyll criteria if EPA had applied the model attainability rules currently being used, i.e. 1% non-attainment rule and requiring attainment in all 3-year assessment cycles in the simulation period.

II. Need to Acknowledge the Basis for the Existing James River Chlorophyll Criteria and the Need to Review/Update those Criteria

- In March 2005, the State Water Control Board adopted water quality standards to protect the Chesapeake Bay and tidal rivers; these standards included five new designated uses, numeric criteria for dissolved oxygen, SAV and water clarity, and a narrative chlorophyll criterion. Action on numeric chlorophyll criteria for the tidal James River was delayed to give further consideration to public comments and to develop nutrient loading and cost alternative analyses. The Board considered the James River chlorophyll criteria at their June 2005 meeting, and adopted criteria at their November 2005 meeting.

- Earlier in the decade EPA chose not to develop Baywide numeric chlorophyll criteria following extensive review, scientific investigation and debate within the Chesapeake Bay Program. Therefore, the cooperative process between the Commonwealth and EPA to develop the chlorophyll criteria for the James River was "plowing new ground". The process resulted in new investigation, using several lines of evidence, such as reference sites, information on harmful or nuisance aquatic plant life, undesirable food conditions, natural characteristics of the James River, and attainability of criteria under various nutrient reductions in the basin.

- Much debate and controversy developed among the stakeholders during the rulemaking process. Legislation drafted by a member of the General Assembly, that would require justification of tangible benefits to the environment and the public, was held in abeyance as long as a solution agreeable to all parties was achieved. Considerable work was devoted to developing and analyzing alternatives with the EPA model to meet various proposed criteria within the five river segments and two seasons. A **James River Alternatives Analysis**, along with four addenda, was developed and became the focus of the on-going debate. EPA model analysis of alternatives, and the model results, became the center of debate throughout this process.

- EPA presented model output, and worked alongside DEQ and the stakeholders in evaluating that model output for the alternatives, in the following ways:

    - Model output was evaluated using 10 year averages of attainment over the assessment period of 1985 to 1994
    - Model output was evaluated without any rule calling for attainment throughout all eight 3-year cycle periods
    - Model output was evaluated without any rule calling for less than 1% non-attainment.

- Based upon that partnership work, DEQ staff, by memo dated June 22, 2005 to the State Water Control Board, in describing the results of the various alternatives evaluated up to that time, stated: *"However, most of the non-attainment under the VATS scenario was less than 4%, which staff believes is within the uncertainty band of the model...."*

- Seventeen alternatives were evaluated by the time the Board adopted the criteria. The final proposal presented to the Board at their November 21, 2005 meeting, which EPA supported, addressed the ten segment-season criteria as follows:
    - Four criteria included upward adjustments from original proposed criteria, using the rationale of "attainability but still within environmentally protective ranges"
    - Two criteria remained unchanged showing non-attainment of 3-4%
    - Four criteria remained unchanged showing attainment

- DEQ submitted the adopted chlorophyll criteria, and supporting documentation to EPA, on January 12, 2006, noting that "Each of these site-specific standards was developed with EPA Region 3 input and assistance."

- EPA approved these criteria by letter dated, January 12, 2006. Approving these standards the same day is a clear indication that EPA was fully involved and aware of the basis for the chlorophyll criteria and supported that process.

- Likewise, EPA provided written support for a related regulatory action during that same period when the State Water Control Board amended the Virginia Water Quality Management Planning regulation to incorporate nutrient allocations for 125 significant discharges, including those within the James River basin to achieve the adopted chlorophyll standards. EPA's letter stated: "The allocations are supportive of Virginia's proposed chlorophyll *a* water quality criteria for the tidal James River and its tidal tributaries."

- Subsequent to the previously described actions, EPA also approved the Chesapeake Bay Watershed General Permit, effective date of January 1, 2007, that included the allocations in the WQMP regulation.

- The Commonwealth clearly understands that the science is evolving regarding the use of chlorophyll criteria in the management of nutrient enrichment of our waters. We intend to initiate a review of the criteria during our next Triennial Review to evaluate any new science and recent monitoring data. We also know that EPA has published criteria to address harmful algae blooms in tidal fresh waters during the summer season. That information will be closely reviewed since the lower tidal fresh segment of the James continues to be an area of concern. We also believe that a full evaluation of the proper assessment tools is warranted, for both monitoring and modeling data.

III. <u>Impacts to Virginia Programs</u>

- Reducing an additional 3.3 MPY of Nitrogen and 0.35 MPY of Phosphorus in the James River basin as called for by the July 1 draft allocations is estimated to cost upwards of an additional $500 Million beyond the cost of implementing Tributary Strategy level of practices.

- Based on our experience during the criteria development process, we are concerned that EPA's July 1 letter will open up the Bay TMDL process in Virginia to legislative response. We are also concerned that the clean-up effort in the Commonwealth will be delayed due to appeals of the TMDL over the July 1 draft allocations.

Attachment A
Comparison of Chlorophyll vs. D.O.

Characteristic	Chlorophyll	Dissolved Oxygen	Implication for Assessment and TMDL
Criteria Parameter Type	Biological Stressor (i.e. Algal Biomass)	Chemical Stressor (i.e. Oxygen Concentration).	*Chlorophyll assessment/TMDL less accurate and precise.*
Impairment Confidence	Lower: Based on relatively difficult to quantify standard of "balanced and indigenous population"	Higher: Based on controlled laboratory studies of direct impact on living organisms. e.g. observed health or death of organisms.	*Chlorophyll assessment/TMDL Impairment level less accurately defined.*
Criteria Evolution	Newer EPA publications since 2005; science still developing	No Change Since 2005	*Chlorophyll criteria should be revised.*
Criteria Metric	Seasonal geometric mean	30 day, 7-day, 1-day, averages; instantaneous	*Chlorophyll assessment/TMDL less precise (Due to longer averaging period*
Parameter Analysis Method	Multi-step Laboratory analysis	Electronic field meter	*Chlorophyll assessment/TMDL data less accurate and precise.*
Data Quantity/Quality Trends	Model is using data collected in 1990's; collection and analysis methods have changed since that time	Methods are high quality; have not changed since beginning in 1985	*Chlorophyll TMDL data less accurate and precise.*
Analytical Method Variability	Higher (16%: median relative percent difference between intra-laboratory splits in James River during 1990's)	Lower (0.7%: ratio of precision [Standard Methods 21st edition] to mean measured summer D.O. during 1990's)	*Chlorophyll assessment less accurate and precise.*
Environmental Variability (1)	Higher (% 116.5 ± 14.0 [spring], %122.3 ± 9.3 [summer])	Lower (% 15.5 ± 0.9 [summer])	*Chlorophyll assessment less accurate and precise.*
Model Calibration	Lower Accuracy	Higher Accuracy	*Chlorophyll TMDL model predictions less accurate.*
Model Prediction Ability	Lower Accuracy	Higher Accuracy	*Chlorophyll TMDL model predictions less accurate.*

1) Average and range of coefficient of variation for four 3-year assessment periods from1990 to 1998.

Attachment B

CBP Segment	2008 IR Arith Mean % non-attain	2008 IR Arith Mean Status	2008 IR Geo Mean % non-attain	2008 IR Geo Mean Status	2010 IR Arith Mean % non-attain	2010 IR Arith Mean Status	2010 IR Geo Mean % non-attain	2010 IR Geo Mean Status
JMSTF1 (James TF Lower) Spring	39	Fails	11	Fails	9	Fails	9	Fails
JMSTF1 (James TF Lower) Summer	47	Fails	46	Fails	33	Fails	31	Fails
JMSTF2 (James TF Upper) Spring	27	Fails	25	Fails	14	Fails	7	Fails
JMSTF2 (James TF Upper) Summer	25	Fails	25	Fails	41	Fails	31	Fails
JMSOH (James Oligohaline) Spring	21	Fails	7	Fails	7	Fails	1	Fails
JMSOH (James Oligohaline)Summer	0	Meets	0	Meets	0	Meets	0	Meets
JMSMH (James Mesohaline) Spring	30	Fails	17	Fails	9	Fails	0	Meets
JMSMH (James Mesohaline) Summer	25	Fails	17	Fails	9	Fails	1	Fails
JMSPH (James Polyhaline) Spring	21	Fails	7	Fails	0	Meets	0	Meets
JMSPH (James Polyhaline) Summer	30	Fails	9	Fails	8	Fails	0	Meets

Note: Above 303(d) assessment results for James River segments are shown with both "old" assessment method (Arith Mean) and "new" assessment method (Geo mean). The 2008 Integrated Report uses monitoring data from 2004 through 2006. The 2010 Integrated Report uses monitoring data from 2006 through 2008. Only "old" method results are reported in the actual published Integrated Reports because "new' method is not yet formally adopted in WQS. Monitoring data used for both periods were combination of both dataflow and fixed site samples. Some segments/periods have a lot of dataflow data available (e.g. JMSPH for both 04-06 and 06-08 periods), others have much less or no dataflow data available (e.g. JMSTF for 06-08 period).

ATTACHMENT Q

To: Principal Staff Committee Members and Representatives of Chesapeake Bay "Headwater" States

From: W. Tayloe Murphy, Jr., Chair
Chesapeake Bay Program Principals' Staff Committee

Subject: Summary of Decisions Regarding Nutrient and Sediment Load Allocations and New Submerged Aquatic Vegetation (SAV) Restoration Goals

For the past twenty years, the Chesapeake Bay partners have been committed to achieving and maintaining water quality conditions necessary to support living resources throughout the Chesapeake Bay ecosystem. In the past month, Chesapeake Bay Program partners (Maryland, Virginia, Pennsylvania, the District of Columbia, the Environmental Protection Agency and the Chesapeake Bay Commission) have expanded our efforts by working with the headwater states of Delaware, West Virginia and New York to adopt new cap load allocations for nitrogen, phosphorus and sediment.

Using the best scientific information available, Bay Program partners have agreed to allocations that are intended to meet the needs of the plants and animals that call the Chesapeake home. The allocations will serve as a basis for each state's tributary strategies that, when completed by April 2004, will describe local implementation actions necessary to meet the *Chesapeake 2000* nutrient and sediment loading goals by 2010.

This memorandum summarizes the important, comprehensive agreements made by Bay watershed partners with regard to cap load allocations for nitrogen, phosphorus and sediments, as well as new baywide and local SAV restoration goals.

Nutrient Allocations

Excessive nutrients in the Chesapeake Bay and its tidal tributaries promote undesirable algal growth, and thereby, prohibit light from reaching underwater bay grasses (submerged aquatic vegetation or SAV) and depress the dissolved oxygen levels of the deeper waters of the Bay.

As a result, Bay watershed states and the District of Columbia, with the concurrence of EPA, agreed to cap annual nitrogen loads delivered to the Bay's tidal waters at 175 million pounds and annual phosphorus loads at 12.8 million pounds. It is estimated that these allocations will require a reduction, from 2000 levels, of nitrogen pollution by 110 million pounds and phosphorus pollution by 6.3 million pounds annually.

The partners agreed upon these load reductions based upon Bay Water Quality Model projections of attainment of proposed water quality criteria for dissolved oxygen. The model projects these load reductions will eliminate the persistent summer anoxic conditions in the deep bottom waters of the Bay. Furthermore, these reductions are projected to eliminate excessive algae conditions (measured as chlorophyll *a*) throughout the Bay and its tidal tributaries.

The jurisdictions agreed to distribute the baywide cap load for nitrogen and phosphorus by major tributary basin (Table 1) and jurisdiction (Table 2). This distribution of responsibility for load reductions was based on three basic principles:

1. Tributary basins with the highest impact on Bay water quality would have the highest reductions of nutrients.
2. States without tidal waters -- Pennsylvania, New York and West Virginia -- would be provided some relief from Principle 1 since they do not benefit as directly from improved water quality in the Bay and its tidal tributaries.
3. Previous nutrient reductions would be credited towards achievement of the cap load allocations.

The nine major tributary basins were separated into three categories based upon their impact on water quality in the Bay. Each basin within a category was assigned the same percent reduction of anthropogenic load. Basins with the highest impact on tidal water quality were assigned the highest percentage reduction of anthropogenic load.

After applying the above calculations and Principle 2, New York, Pennsylvania and West Virginia allocations were set at "Tier 3" nutrient load levels. Additionally, allocations for Virginia's York and James River basins were set at previously established tributary strategy nutrient cap load levels since each basin has minimal impact on mainstem Bay water quality conditions, and their influence on tidal water quality is predominantly local.

These rules resulted in shortfalls to the baywide cap load allocation of 12 million pounds of nitrogen and 1 million pounds of phosphorus. EPA committed to pursue the Clear Skies initiative which is estimated to reduce the nitrogen load to Bay tidal waters by 8 million pounds per year. Bay watershed states agreed to take responsibility for the remaining 4 million pounds of nitrogen and 1 million pounds of phosphorus. The nutrient cap load allocations in tables 1 and 2 reflect these agreements.

The allocations for nitrogen and phosphorus were adopted with the concept of "nitrogen equivalents" and a commitment to explore how actions beyond traditional best management practices might help meet Bay restoration goals. A nitrogen equivalent is an action that results in the same water quality benefit as removing nitrogen. The Chesapeake Bay Program will evaluate how to account for tidal water quality benefits from continued and expanded living resource restoration, such as oysters and menhaden, to offset the reductions of watershed based nutrient and sediment loads. Seasonal fluctuations for biological nutrient removal implementation, nutrient reduction benefits from shoreline erosion reductions, implementation of enhanced nutrient removal at large wastewater treatment plants, and trade-offs between nitrogen and phosphorus will also be evaluated.

Baywide SAV Restoration Goal

To set new SAV restoration goals, scientists and resource managers from state and federal agencies agreed to use data from the single best year of observed SAV growth to estimate the historical long-term bay grass coverage in Chesapeake Bay. Data were collected from aerial photographs taken between 1938 and 2000. From 3-4 years in the 1938 -1964 period, and more than 20 years of data since 1978, new baywide SAV restoration goal acreage was determined by totaling the single best year acreage from each Chesapeake Bay Program segment.

The states have adopted 185,000 acres as the new baywide SAV restoration goal to be achieved by 2010 – consistent with the goals of *Chesapeake 2000.* The achievement of the baywide goal, as well as the local tributary basin and segment specific restoration goals summarized in Table 3, will be based on the single best year SAV acreage within the most recent three-year record of survey results. This new acreage goal has been added to the recently adopted strategy to accelerate the protection and restoration of SAV in the Chesapeake Bay; and Maryland and Virginia have agreed to develop an implementation plan for this strategy by April 2004.

Sediment Allocations

Sediments suspended in the water column reduce the amount of light available to support healthy and extensive SAV communities. With regards to the sediment allocations, the partners agreed that a primary reason for reducing sediment loads to the Bay is to provide suitable habitat for restoring SAV. The jurisdictions also agreed that nutrient load reductions are critical for SAV restoration as well as improving oxygen levels. As a result, the states linked the establishment of sediment cap load allocations to the proposed water clarity criteria and to the new SAV restoration goals.

Unlike nutrients - where loads from virtually all parts of the Bay watershed affect Bay mainstem water quality - impacts from sediments are predominantly seen at the local level. For this reason, local SAV acreage goals have been established and sediment allocations are targeted towards achieving those restoration goals.

The partners recognize that the current understanding of sediment sources and their impact on the Bay is not yet complete. We have only a basic understanding of land-based sediments that are carried into local waterways through stream bank erosion and runoff, but a more limited knowledge about near shore sediments that enter the Bay and its tidal rivers directly through shoreline erosion or shallow-water resuspension. Consequently, sediment allocations are currently focused on land-based sediment cap loads by major tributary basin (Table 1) and jurisdiction (Table 2).

Most land-based best management practices which reduce nonpoint sources of phosphorus will also reduce sediment runoff. Therefore, the jurisdictions agreed to land-based sediment allocations that represent the sediment loading likely to result from implementation management actions required to achieve the phosphorus cap load allocations.

The sediment allocation was set equal to the tier level for phosphorus allocation for each jurisdiction-basin. This is referred to as the 'phosphorus equivalent' land-based sediment reduction. If the 'phosphorus equivalent' land-based sediment reductions were found to be more than necessary to achieve the local SAV acreage goals, then the land-based sediment allocations were raised to that necessary to achieve the SAV goal. The tidal fresh Susquehanna Flats and tidal fresh Potomac River are two examples where this modified approach was applied. If, in the development of their tributary strategies, tributary teams conclude that the land-based sediment allocations need revisions, the tributary teams may identify an alternate land-based allocation working with all the jurisdictions within the effected basin. For example, a jurisdiction may select different nonpoint source management actions than those prescribed in the tier approach to reach the phosphorus goal; the jurisdiction may adjust the sediment goal accordingly so long as SAV restoration and protection is not compromised.

It is likely that reduction in nutrients and land-based sediments alone will not be sufficient to achieve the local SAV goals for many areas of the Bay. In these areas, tributary teams will be asked to further assess varied and innovative methods to achieve SAV re-growth. Such methods may include, but are not limited to SAV planting, offshore breakwaters, shore erosion controls, beach nourishment, establishment of oyster bars, and other actions as appropriate.

Support to State Tributary Strategies

The partners have agreed to complete their nutrient and sediment reduction strategies by April 2004. To assist in the development of tributary strategies, the Chesapeake Bay Program Office will provide an array of technical analyses, water quality and watershed modeling, cost-effectiveness and economic assessment support to the tributary strategy teams through the states.

The jurisdictions agreed that it is critical to work together to assure the aggregate of control actions recommended within the nutrient and sediment strategies yield the load reductions and the Bay and tidal tributary water quality improvements desired.

Reevaluation of the Allocations

The nutrient and sediment cap load allocations adopted by the jurisdictions are the best scientific estimates of what will be needed to attain proposed water quality criteria and tidal water designated uses described in guidance published by EPA. Over the next two years, Maryland, Virginia, Delaware and the District of Columbia will promulgate new water quality standards based on the guidance published by EPA.

Although the public process for adopting water quality standards varies among the states, each state's process will provide opportunities for considering and acquiring new information at the local level. States may choose to explore a number of issues during their adoption process, such as the economic impact of water quality standards and specific designated use boundaries.

While the allocations adopted at this time will provide the basis for tributary strategies, these allocations may need to be adjusted to reflect final state water quality standards. Furthermore, planned Bay model refinements - directed towards estimating water quality benefits from filter feeding resources (e.g., oysters and menhaden) and better understanding the sources and effects of sediments - will increase our understanding of the relationship between nutrient and sediment reductions and living resource responses in the Bay. For these reasons, the states agreed to a reevaluation of these allocations no later than 2007.

As partners, the jurisdictions committed to correcting the nutrient and sediment related problems in the Bay and its tidal tributaries sufficiently to remove them from the list of impaired waters under the Clean Water Act. Although the states agreed to do their utmost to remove the Bay from the federal list of impaired waters by 2010, they recognize that it will be difficult to meet projected water quality standards in all parts of the Bay by that time. A key reason for this difficulty is that once nutrient reduction practices are installed, it may be years or even decades before the Bay benefits from these reductions. The jurisdictions intend to have programs in place and functioning by 2010 such that when fully implemented all parts of the Bay are expected to become eligible for delisting.

I would like to express my appreciation to all the partners in this effort for their hard work and commitment to restoration of the Chesapeake Bay. We have agreed to nutrient and sediment reductions which will result in profound improvements in the water quality, habitat and living resources of the Bay.

Attachments

ATTACHMENT R

Geo_run	P51 DEL	P51 EOS	P51 DEL PS	P51 EOS PS	P51 DEL NPS	P51 EOS NPS	DF_PS	DF_NPS	Mean DO_effective	GeoDel_PS	GeoDel_NPS
Susq	1.91	2.48	0.021	0.027	1.89	2.46	0.76	0.77	9.679	7.384	7.442
lMDB	11.41	12.72	0.520	0.526	10.89	12.19	0.99	0.89	8.050	7.951	7.193
uMDB	9.04	9.41	0.281	0.282	8.75	9.13	1.00	0.96	7.265	7.250	6.969
lMDB	5.82	6.85	0.324	0.324	5.50	6.53	1.00	0.84	8.050	8.050	6.780
uMDB	0.64	0.72	0.000	0.000	0.64	0.72	0.89	0.89	7.265	6.499	6.499
Wshore	18.78	23.67	11.341	11.438	7.43	12.23	0.99	0.61	8.109	8.040	4.930
mMDB	5.95	6.43	0.217	0.218	5.73	6.21	1.00	0.92	6.839	6.811	6.309
Susq	118.21	185.24	11.565	16.654	106.65	168.59	0.69	0.63	9.679	6.721	6.122
PotB	12.43	12.66	12.157	12.157	0.27	0.50	1.00	0.53	6.115	6.115	3.263
EshVA	2.54	2.54	0.284	0.284	2.26	2.26	1.00	1.00	5.834	5.834	5.834
uMDB	0.55	0.70	0.016	0.023	0.54	0.67	0.71	0.80	7.265	5.130	5.778
PxtB	3.07	3.42	0.553	0.553	2.52	2.86	1.00	0.88	6.139	6.139	5.400
PotA	2.85	2.95	2.800	2.901	0.05	0.05	0.97	0.97	5.383	5.197	5.197
PotB	5.49	6.56	1.207	1.208	4.28	5.35	1.00	0.80	6.115	6.107	4.891
PotB	11.82	15.92	6.956	7.930	4.86	7.99	0.88	0.61	6.115	5.364	3.721
RapB	5.47	5.57	0.438	0.438	5.03	5.14	1.00	0.98	4.504	4.504	4.412
mMDB	0.57	0.94	0.000	0.000	0.57	0.94	0.61	0.61	6.839	4.164	4.164
Susq	15.84	36.87	2.680	4.947	13.16	31.93	0.54	0.41	9.679	5.244	3.989
PotA	20.39	52.46	0.820	1.896	19.57	50.57	0.43	0.39	5.383	2.327	2.083
YrkB	6.45	6.72	1.360	1.505	5.09	5.22	0.90	0.98	1.926	1.741	1.879
PotA	16.88	61.81	0.522	2.730	16.36	59.08	0.19	0.28	5.383	1.030	1.490
PotA	8.24	37.21	0.575	3.297	7.66	33.91	0.17	0.23	5.383	0.938	1.216
Wshore	0.02	0.13	0.000	0.000	0.02	0.13	0.13	0.13	8.109	1.065	1.065
PotA	6.62	34.73	0.127	0.664	6.49	34.06	0.19	0.19	5.383	1.027	1.026
PxtA	1.54	5.58	0.364	0.649	1.18	4.93	0.56	0.24	3.110	1.744	0.742
JmsB	25.70	27.97	17.475	17.562	8.23	10.41	1.00	0.79	0.798	0.794	0.631
RapA	5.03	18.92	0.090	0.286	4.94	18.64	0.31	0.26	2.669	0.838	0.707
YrkA	2.66	7.52	0.097	0.241	2.56	7.28	0.40	0.35	1.119	0.449	0.394
JmsA	13.68	52.21	0.561	2.570	13.12	49.64	0.22	0.26	0.654	0.143	0.173
JmsA	0.02	0.39	0.000	0.000	0.02	0.39	0.04	0.04	0.654	0.025	0.025
	339.61	641.32	73.351	91.312	266.26	550.01	20.57	18.24	169.493	124.625	110.325

Above data received from Jing Wu on 7-31-09 and were qualified as draft and subject to change.

ATTACHMENT S

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

NOV - 3 2009

The Honorable L. Preston Bryant, Jr.
Secretary of Natural Resources
Patrick Henry Building
1111 East Broad Street
Richmond, Virginia 23219

Dear Secretary Bryant:

The purpose of this letter is to provide the Chesapeake Bay Program's Principals' Staff Committee (PSC) with the preliminary basinwide target loads for nitrogen and phosphorus and the working target loads for nitrogen and phosphorus for the basin-jurisdictions to meet the states' Bay dissolved oxygen water quality standards in the Chesapeake Bay and its tidal tributaries. The U.S. Environmental Protection Agency (EPA) expects these loads to continue to be refined as the science unfolds. These working targets allow each of the jurisdictions to begin development of their Watershed Implementation Plans (Plans) and to move the Chesapeake Bay Total Maximum Daily Load (Bay TMDL) development forward. Today, EPA has also issued a separate letter setting forth our expectations regarding the Plans. This letter also details the schedule necessary to meet EPA's commitment to complete the Bay TMDL by December 2010.

Nutrient Target Loads

At the October 23, 2009, PSC meeting, EPA and the PSC agreed to preliminary basinwide target loads of 200 million pounds per year of nitrogen and 15 million pounds per year of phosphorus as recommended by the Water Quality Goal Implementation Team (WQGIT). These preliminary basinwide target loads for nitrogen and phosphorus have been shown through subsequent model runs as being adequate to achieve the states' Bay dissolved oxygen water quality standards.

It is important to note that the preliminary basinwide target loads will likely change several times leading up to a draft TMDL and final TMDL. These targets will undergo several revisions based on further technical analysis, additional deliberations among the states, the District of Columbia (District) and EPA, and at least two major opportunities for public input. The primary technical issues under consideration that will likely change these loads include: application of the upgraded Chesapeake Bay watershed model (Phase 5.2 to 5.3); inclusion of filter feeders in the Bay water quality/sediment transport model; development of sediment load targets to achieve the states' Submerged Aquatic Vegetation (SAV)/water clarity water quality standards; development of the atmospheric deposition allocations and the resultant impact on the ocean loads; trade-offs between nitrogen and phosphorus loads; and additional load reductions necessary to address Bay segments' local water quality impairments. Furthermore, EPA recognizes the need for further discussions with the watershed jurisdictions on the methodology for distributing loads.

In spite of likely future changes to the basinwide target loads, EPA considers the preliminary target loads—200 million pounds per year of nitrogen and 15 million pounds per year of phosphorus—to be appropriate for the purpose of distributing these loads to the basin-jurisdictions as working target loads to initiate the watershed implementation planning process in all six Bay watershed states and the District.

EPA and the PSC agreed, with New York abstaining, to distribute the basinwide load targets for nitrogen and phosphorus as working target loads to each of the basin-jurisdictions within the Chesapeake Bay watershed as recommended by the WQGIT at the October 23, 2009 PSC meeting. Furthermore, EPA and the PSC agreed that these working target loads are non-binding and do not represent a draft TMDL. The working target loads are shown in the enclosed Tables 1 and 2 by basin and jurisdiction, respectively. Additionally, EPA and the PSC determined that states and the District have the latitude to exchange target loads within a state from one basin to another or to exchange nitrogen and phosphorus loads within a basin to create alternate target loads as long as these load exchanges achieve the states' water quality standards in all tidal Bay segments. Adoption of these working target loads allows for the jurisdictions to move forward and engage local partners in development of their Plans.

Schedule of major milestones and completion of the Bay TMDL

EPA is committed to establishing the Bay TMDL by December 2010. In spite of best efforts, the important steps of determining the basinwide target loads and initial working basin-jurisdiction target loads have been delayed by several months. This delay has caused a commensurate delay in the states' efforts to develop the Plans. These Plans are important not only to guide state and local efforts but the load targets in the Plans will be incorporated into the draft and final Bay TMDL.

While the states and the District have less time to complete the Plans, EPA believes that the adaptive management approach that EPA has built into the planning process enables the states to make necessary adjustments in how they are to achieve the needed load reductions, after the TMDL is established. Shortening the public participation to 60 days from 90 days as well as shortening time allotted for EPA and the states to respond to public comments will allow more time for the states to develop their Plans in concert with their local partners.

With these modifications, the major milestones of the Bay TMDL development schedule are described below:

- November-December, 2009: EPA hosts 15 public meetings throughout the Bay watershed to start the public dialog on the Bay TMDL.
- June 1, 2010: States and the District submit preliminary draft Watershed Implementation Plans with target loads by source sector and Bay segment drainage to EPA.
- July 15, 2010: PSC reviews the initial draft Bay TMDL package; provides specific directions to WQGIT on requested changes.
- August 1, 2010: States and the District submit revised draft Plans to EPA.
- August 15-October 15, 2010: Bay TMDL public review and second round of public meetings.
- November 1, 2010: States and the District submit final Plans to EPA.

- November 15, 2010: PSC reviews/provides specific comments to EPA on the draft final Bay TMDL package—allocations, watershed plans, underlying documentation.
- December 21, 2010: EPA publication of final Bay TMDL.
- November 1, 2011: States and the District incorporate local target loads into their plans and submit to EPA.

EPA expects the Bay watershed states and the District to immediately move forward to engage local partners on development of the Plans and local-level/source sector target loads. EPA Region III in coordination with EPA Region II is committed to working with the Bay watershed states and the District to facilitate Plan development. EPA will provide technical analyses, water quality and watershed modeling, and contractual assistance to support the watershed implementation planning process in each of the six states and the District.

If you have any questions, please contact Mr. Jon M. Capacasa, Director, Water Protection Division, at (215) 814-5422.

Sincerely,

William C. Early
Acting Regional Administrator

Enclosures

cc: Chesapeake Bay Program Principals' Staff Committee Members
Peter Silva, Assistant Administrator, Office of Water, EPA
J. Charles Fox, Senior Advisor to the Administrator, EPA
George Pavlou, Acting Regional Administrator, EPA Region II

Table 1. Preliminary Chesapeake Bay Watershed Nitrogen and Phosphorus Working Target Loads by Basin[1]		
Basin/Jurisdiction	Nitrogen Target Load (million pounds per year)	Phosphorus Target Load (million pounds per year)
SUSQUEHANNA		
NY	10.54	0.56
PA	68.81	2.69
MD	0.83	0.05
SUSQUEHANNA Total	80.18	3.29
EASTERN SHORE		
DE	5.25	0.28
MD	12.81	1.24
VA	1.61	0.15
EASTERN SHORE Total	19.68	1.68
WESTERN SHORE		
MD	10.15	0.62
WESTERN SHORE Total	10.15	0.62
PATUXENT		
MD	3.15	0.24
PATUXENT Total	3.15	0.24
POTOMAC		
PA	4.83	0.47
MD	14.10	0.89
DC	2.37	0.13
VA	16.09	1.97
WV	5.71	0.62
POTOMAC Total	43.10	4.08
RAPPAHANNOCK		
VA	6.49	0.82
RAPPAHANNOCK Total	6.49	0.82
YORK		
VA	6.53	0.61
YORK Total	6.53	0.61
JAMES		
VA	28.49	3.50
JAMES Total	28.49	3.50
TOTAL WORKING TARGET LOAD	**197.76**	**14.84**

[1] To match with the states tributary strategy basins, the nitrogen and phosphorus loads from the Western Shore and Eastern Shore basins in Pennsylvania have been added to the Pennsylvania Susquehanna basin loads and the West Virginia James basin loads have been added to the West Virginia Potomac loads.

Table 2. Preliminary Chesapeake Bay Watershed Nitrogen and Phosphorus Working Target Loads by Jurisdiction[2]		
Jurisdiction/Basin	Nitrogen Target Load (million pounds per year)	Phosphorus Target Load (million pounds per year)
PENNSYLVANIA		
Susquehanna	68.81	2.69
Potomac	4.83	0.47
PA Total	73.64	3.16
MARYLAND		
Susquehanna	0.83	0.05
Eastern Shore	12.81	1.24
Western Shore	10.15	0.62
Patuxent	3.15	0.24
Potomac	14.10	0.89
MD Total	41.04	3.04
VIRGINIA		
Eastern Shore	1.61	0.15
Potomac	16.09	1.97
Rappahannock	6.49	0.82
York	6.53	0.61
James	28.49	3.50
VA Total	59.22	7.05
DISTRICT OF COLUMBIA		
Potomac	2.37	0.13
DC Total	2.37	0.13
NEW YORK		
Susquehanna	10.54	0.56
NY Total	10.54	0.56
DELAWARE		
Eastern Shore	5.25	0.28
DE Total	5.25	0.28
WEST VIRGINIA		
Potomac	5.71	0.62
WV Total	5.71	0.62
TOTAL WORKING TARGET LOAD	**197.76**	**14.84**

[2] To match with the states tributary strategy basins, the nitrogen and phosphorus loads from the Western Shore and Eastern Shore basins in Pennsylvania have been added to the Pennsylvania Susquehanna basin loads and the West Virginia James basin loads have been added to the West Virginia Potomac loads.